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An Ornamental and Cheap Concrete Bridge

By R. C. Hardman*

A reinforced-concrete viaduct that presents some more or less unusual features has recently been completed at Cañon City, Colo. Among these features, aside from the smallness of the city for which the work was done, was the low cost of the structure—approximately $1.40 per sq.ft. of roadway and walk.

Cañon City, having a population of 5162 in 1910, is situated in the center of a large apple-growing territory along the Arkansas River at the mouth of the famous Royal Gorge of the Arkansas. On the south bank of the river is South Cañon, Prospect Heights and Lincoln Park, with a tributary population of some 2000 persons. The river is spanned by three steel highway bridges. In an attempt to draw traffic, and incidentally business, from the tributary population to the old portion of the city, the taxpayers organized an Improvement District and voted bonds for the construction of the viaduct. Thus the structure was built for business reasons rather than from necessity.

FIG. 1. REINFORCED-CONCRETE VIADUCT AT CANON CITY, COLO.
North end is to the left

The viaduct extends over an old swampy river bed, an alley, a large power and irrigation canal, the main line of the Denver & Rio Grande R.R., a small unused irrigation ditch, a roadway, the main line and three sidings of the Atchison, Topeka & Santa Fe Ry., joining a steel river bridge at the south end.

The structure has a roadway 23 ft. 11 in. in width between curbs and one sidewalk 4 ft. 11 in. in width. A vertical clearance of 26 ft. is provided over the Denver & Rio Grande and 23 ft. over the tracks of the Atchison, Topeka & Santa Fe. The north end, 27 ft. of which is an earth fill between retaining walls, has an ascending grade of 5.94% for a distance of 262.67 ft. Over the Denver & Rio Grande the grade is level for a distance of 65 ft., followed by 208.83 ft. of a 1.39% descending grade, which in turn connects with the river bridge by a descending grade of 8.11%, 255.5 ft. in length. The river bridge, a Pratt truss 105 ft. long, was raised 5 ft. at the north end in order to reduce the gradient of the connecting viaduct. The last 50 ft. of the 8.11% grade is an earth fill between retaining walls, from which an earth descent on a 10% grade affords access to the level of the tracks and roadway.

The total length of the viaduct is 742 ft., of which 665 ft. is of concrete and 77 ft. is earth fill. The structure is of a girder-and-slab type, which was selected in order to secure the required clearance over the railroad tracks for the full width of the rights-of-way without entailing the steeper approach grades which an arch type would have necessitated. No uniform length of span was feasible because of the fixed points at which so many of the piers were best located. The spans vary in length from 27 to 44 ft. for the regular spans, with one of 60 ft. and one of 65 ft. over the railroad tracks.

The committee having charge of the building of the viaduct desired it to have as massive an appearance as possible compatible with low cost. For this reason the type of support shown in Fig. 2 was selected instead of the usual slender, heavily reinforced column. As will be seen, the support, or pier, consists essentially of three plain concrete posts joined at the top by semicircular arches, also unreinforced. These posts, which are 4x5

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ft. in plan in four piers and 4x4 ft. in eleven piers, have battered bottoms resting upon a footing carried to an underlying bed of boulders at depths of from 3 to 9 ft. All piers were constructed before any superstructure was placed.

The superstructure is of the girder-and-slab type designed for a loading of 100 lb. per sq.ft. of roadway and walk, or a 15-ton road roller. The railroad rights-of-

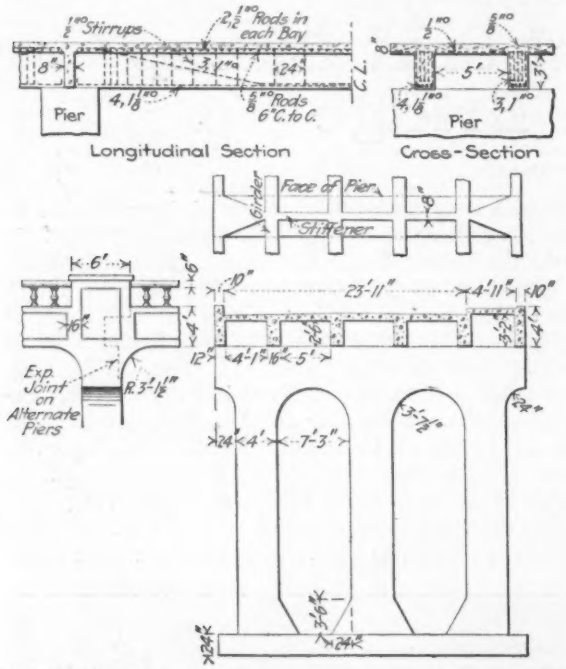


FIG. 2. DETAILS OF TYPICAL PIER AND GIRDER SPAN OF CANON CITY VIADUCT

way are spanned by steel plate-girders carrying a concrete floor-slab as shown in section in Fig. 3, in which a unique lateral stiffening was carried out. The outside girders in each span were incased in concrete on one side only, to conform in architectural treatment to the remainder of the structure. The method by which this was accomplished is clearly shown in Fig. 3.

Typical sections of the concrete spans, which present nothing unusual, are shown in Fig. 2. The placing of the girders on the piers is unique in that all piers are essentially free except for the meager bond between old

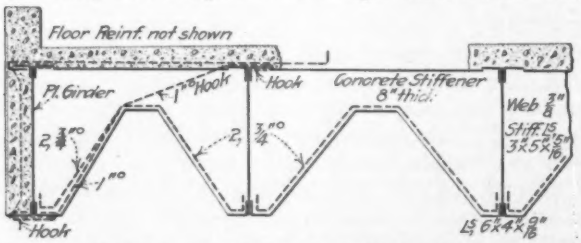


FIG. 3. DETAILS OF CONCRETE-INCASED PLATE-GIRDER

and new concrete, as no reinforcement was used to tie the pier and girder together.

In the construction of forms no timber heavier than a 2x4 was used for the piers, although continuous pouring of concrete to a height of 31 ft. was accomplished. For shoring doubled 2x4's and 2x6's were used with lateral and diagonal bracing of 1x6's and 1x8's. The forms for the girders were built complete on the ground. They were then hoisted by means of one gin-pole, placed in position on the piers, spaced and braced. Each girder form being entirely self-supporting, the floor joists and lagging was next placed, the shoring-up being left until the end.

As the amount available for the structure was limited, the keynote of the viaduct was simplicity in every detail, with a minimum of costly architectural treatment. Practically the only architectural treatment consisted of a few segmental haunches, paneling of the outside girders and a cast balustrade, neither of which was costly. There being no difficulties of design, the only problem was to obtain a combination of massive appearance with beauty and low cost. The degree of success attained may be judged by the accompanying view of the structure.

The bridge was designed and built by the writer as engineer for the Central Construction Co., of Colorado Springs, Colo.

As the site was examined, plans and details made, estimate prepared and contract let in but ten days' time, the viaduct will not, perhaps, stand as a model of engineering design, as many little refinements could well have been introduced had time permitted. However, as an example of what can be done for a comparatively low cost, it may merit this description.

Load Tests on Brick Piers*

The crushing strength of brick piers of large size is under investigation by the Bureau of Standards in Pittsburgh, Penn. So far more than 22 piers have been tested. As nearly as possible each pier was 30 in. square by 10 ft. high, except two piers which were built 5 ft. high. Each pier averaged 44 courses. The joints were about $\frac{5}{16}$ in. thick. The qualities of brick used, kinds of mortar, ages of piers and results of tests are tabulated in Fig. 1. Three typical styles of bonding were selected for test—header every other course, every fourth course and every seventh course; thus there were three types of bonding for each set of piers. One of the 5-ft. piers had steel-mesh reinforcing placed in every horizontal joint; the other, every four courses; but the results obtained were inconclusive (see Conclusion No. 7).

Method of Test

Each pier was constructed in the laboratory on a steel plate 1 in. thick, leveled on the floor. The plate surface which was to rest on the base of the testing machine was planed. A plate 1½ in. thick, with eye-bolts for crane connections, was laid on the top of the finished pier, connected with the baseplate by four vertical rods, so that the piers could be lifted easily and set in the testing machine without injury. The top plate was removed after the pier was in place. The pier was leveled, the top covered with a thin coat of plaster of paris, and the head of the machine brought down, squeezing out superfluous material. The pier was then left for several hours to

*Abstract of paper by J. H. Griffith and J. G. Bragg, Bureau of Standards, Pittsburgh, Penn., presented before the recent meeting of the National Brick Manufacturers' Association. It is based on an investigation being conducted by the Bureau of Standards in Pittsburgh to determine the physical properties of large piers when tested to destruction. The investigation was inaugurated by the N. B. M. A. under its Committee on Technical Investigations (Prof. Edward Orton, Chairman) and was taken up in coöperation with the Bureau of Standards through Prof. A. V. Bleininger, Ceramic Chemist, who acted in an advisory capacity in the conduct of the work.

allow the plaster to set. Measurements of compression were made at several corners, as were also transverse measurements and strains between bricks.

As shown in Fig. 1, bricks laid up in cement mortar stood up best. Cement-lime mortar gave almost as good results. Piers using lime mortar were only about one-half as strong as those with cement; but it should be noted that vitrified brick laid up in lime mortar withstood a pressure of more than 1400 lb. per sq.in. The weakness of these piers was caused mainly by an almost entire lack of carbonation of the mortar on the interior, rather than by any special inefficiency of lime mortar when properly aged.

Characteristic Failure of Piers

At about three-fourths maximum load vertical haircracks began to appear. With continued loading the piers broke up into vertical laminations. This condition was induced by the bending of the individual bricks, causing them to split transversely. The bending is the result of nonuniform bearing proceeding from lack of homogeneity of texture in the pier, in an individual brick or in the mortars.

The progressive action of this cracking is most interesting. Sometimes very early in the test small haircracks formed in the upper or lower surface of a brick, usually just under or near the vertical joints, and widened at the surface as the load increased. Finally, subdued sounds

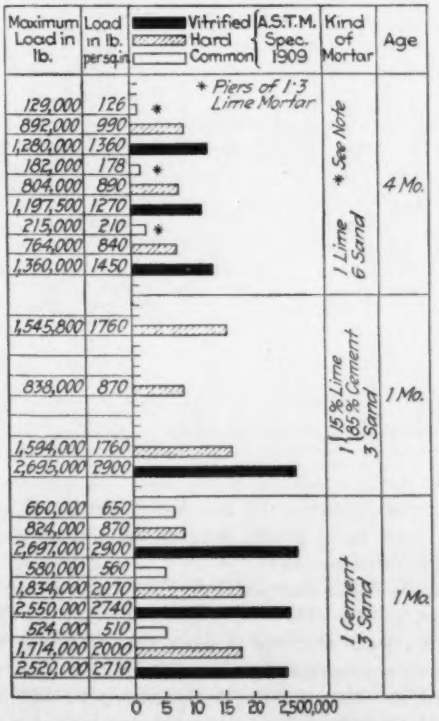


FIG. 1. DATA OF LOAD TESTS

were heard, which increased in volume until, in the case of vitrified and hard-burned brick laid up in lime mortar, a succession of popping sounds occurred, frequently increasing until the sound became a loud "bubbling" in the final stages. When a brick split, the ones above and below tended to do the same, until the structure became a succession of strips, and failed either by spalling out in large masses or as a group of thin, isolated columns.

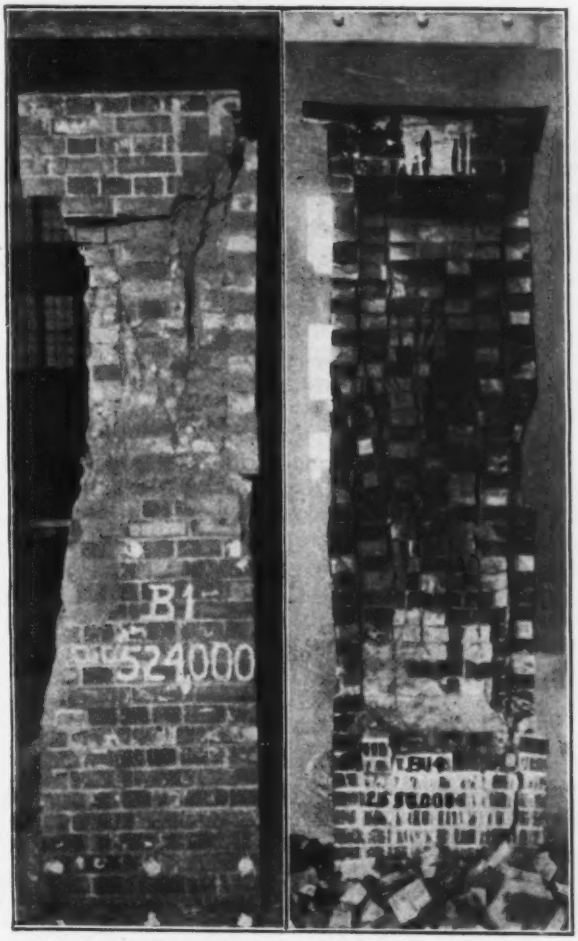


FIG. 2. FAILURE BY SPALLING (LEFT) AND BY VERTICAL CLEAVAGE (RIGHT)

Left—Common brick—cement mortar 1 : 3; maximum unit load, 580 lb. per sq.in. Right—Vitrified brick—cement mortar 1: 3; maximum unit load, 2833 lb. per sq.in.

The following are the main conclusions reached in the investigation:

(1) The strength of piers under vertical loading bears a close relation to the kind of brick used and the quality and age of the mortar.

(2) The low strength of piers laid in lime mortar is attributed in the main to insufficient aging, with a consequent lack of a proper carbonation of the mortar.

(3) Experiments seem to indicate that the strength of a pier is largely independent of the course bonding. The real function of bonds is to maintain a certain integrity and monolithic action of the masonry against initial strains induced through setting and "drying out" of the mortar rather than to give any great increase of vertical strength.

(4) The elastic limit of the piers laid up in cement and cement-lime mortar was approximately one-half the maximum load.

(5) Piers fail through a tendency to separate into vertical strips caused by bending failure in the individual brick produced by unequal distribution of the vertical load over the cross-section. This is aggravated by ineffective shearing and adhesive strength of the mortar.

(6) A high modulus of rupture of the brick is more desirable than superior crushing strength. Higher modulus of rupture would be realized in practice by increasing the thickness of the bricks or by laying them on edge.

(7) A further study of the action of steel-mesh reinforcing in the horizontal joints is recommended in order to ascertain the load efficiency of piers having an outer shell of hard brick with an inner core of softer brick. This construction would be used where a high-grade brick is not easily obtainable.

Sixty-Seven Breaks in a Cast-Iron Water Main

By C. E. Davis*

Sixty-seven breaks have occurred since 1893 in the 30-in. cast-iron main known as the Hartwell Ave. line of the Philadelphia water-works. This main is about 2½ miles long and delivers water from the Roxborough high-service standpipe to Chestnut Hill.

Over a large part of its length the pipe line is laid in unimproved country road, and it is nowhere subjected to heavy or frequent traffic. There has been no disturbance from adjacent excavations, nor has there been any settlement or yielding of the ground in which the line is laid. The pipe has a comparatively light cover of earth and is probably quickly affected by temperature changes.

A parallel main to the Hartwell Ave. line, drawing likewise from the Roxborough standpipe and leading to Chestnut Hill, is laid on Rex Ave. The accompanying profiles show the heads under which the two mains are operated. The Hartwell Ave. profile shows the locations of the several breaks.

The Rex Ave. line was laid in 1902 and has given no trouble. The Hartwell Ave. line, as before stated, has broken 67 times since it was laid in 1893. Both mains are operated under the standpipe head indicated on the profile, and under normal conditions this standpipe is directly connected with the discharge from the pumping station. The mains feed substantially the same distribution system at Chestnut Hill and are cross-connected.

The Hartwell Ave. pipe was furnished by the Reading Foundry & Machine Co., which discontinued the manufacture of pipe a number of years ago. The specifications under which it was manufactured are not available, and no record of tests of the pipe is extant. The thickness of the metal in the body of the pipe appears to be about what is called for under present standard specifications for the head under which it is operated.

The direct cause of these numerous breaks appears to be a poor quality of cast iron, as indicated by the following typical analysis, in which special attention is called to the high phosphorus:

Silicon, 1.85; sulphur, 0.097; manganese, 0.361; phosphorus, 1.33; combined carbon, 0.526; gr. carbon, 2.756; total, 3.282.

Some significance should be attached to the fact that in a distance of one thousand feet easterly from the Wissahickon Creek no breaks have occurred. An analysis of the iron in the pipes laid in this section is not available, but an external examination indicates that it is of a better quality than in the sections where the breaks have occurred. Reports from workmen replacing the broken pipes corroborate the conclusion that the iron is inferior in quality. These reports are invariably to the effect that the pipe is easily broken up.

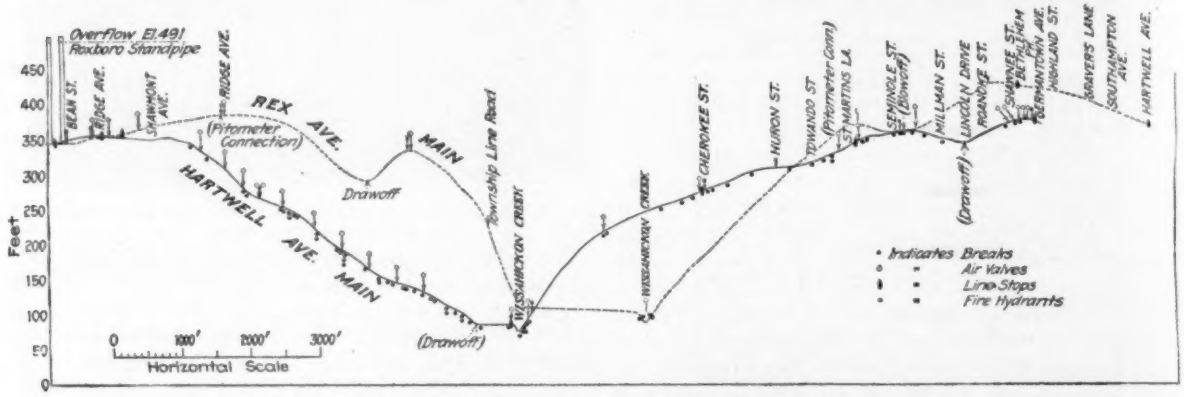
No particular significance can be attached to the character and location in the individual pipes of the several fractures, except that these still further corroborate the conclusion that the metal is poor. Frequently, a piece is found broken out bodily from the barrel of the pipe and entirely freed from the rest of the casting.

The following table gives a record of the 67 breaks by years since the pipe was laid and by months of the year:

BREAKS IN HARTWELL AVE. WATER MAIN

Year	Breaks	Year	Breaks	Month	Breaks
1894	3	1905	4	January	9
1895	5	1906	2	February	8
1896	5	1907	2	March	5
1897	0	1908	3	April	5
1898	2	1909	2	May	5
1899	7	1910	2	June	2
1900	2	1911	4	July	3
1901	6	1912	6	August	4
1902	0	1913	5	September	5
1903	2	1914	3	October	6
1904	1	1915	1	November	8
				December	13
Total for the 22 years			67		

The seasonal variation in the breaks may be significant, but there are no data available which indicate that any difference in the operation of the main could account for the slight variation in the number of breaks in an individual year, these breaks ranging from none to seven in a single calendar year.



PROFILES OF HARTWELL AND REX AVE. WATER MAINS, PHILADELPHIA

The joints on the Hartwell Ave. line are ordinary lead-and-gasket joints. They have given no unusual trouble either from leaks or from blowing out, all the difficulty having been concentrated in broken castings. Air valves are placed on the summits at the standpipe end of the main, and these have been operated regularly for many years. Additional air valves have recently been placed at frequent intervals throughout the entire length of the line. There is no definite record of the actual grades to which the main is laid, but the surface of the ground appears to preclude the probability of summits other than those indicated on the accompanying profile. This conclusion is corroborated by the fact that the additional air valves show no evidence of an accumulation of air in the pipes.

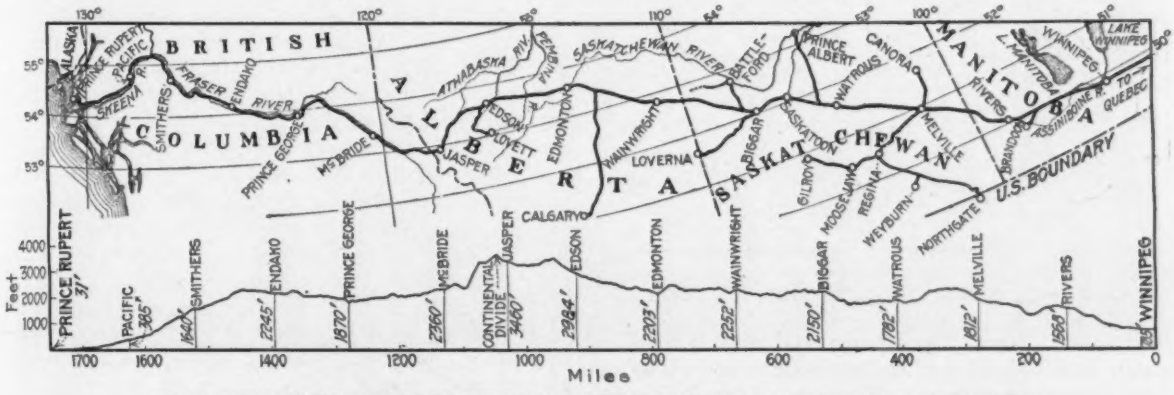
*Chief of Bureau of Water, Philadelphia, Penn.

The absence of air and hammer, the freedom from trouble in the parallel Rex Ave. main, the chemical analysis of the iron from the Hartwell Ave. pipe, and the corroborative testimony of the ease with which the iron is broken by workmen lead to the conclusion that a poor quality of metal was responsible for the frequent breaks in the Hartwell Ave. main.

Grand Trunk Pacific Ry.

The Grand Trunk Pacific Ry. was opened for through commercial traffic between Winnipeg and Prince Rupert, 1748 mi., on Sept. 1, 1914 (steel having been joined Apr. 7, 1914), thus completing the second transcontinental railway in Canada. The eastern section of the line from Moncton, N. B., to Winnipeg, constructed by the Canadian Government, was described in *Engineering News*, June 27, 1912. The western section was built by the Grand Trunk Pacific Ry., and is operated by that company.

Construction was commenced in 1905, and has been under the direction of B. B. Kelliher, Chief Engineer. He resigned his position in the fall of 1914, and the work is now under H. A. Woods, who has been Assistant Chief Engineer for several years. Some of the difficult work along the Fraser River was described in *Engineering News*, Oct. 8, 1914. A condensed map and profile are given in the accompanying illustration. There is a total rise of 2938 ft. from Winnipeg (785 ft.) to the Rocky Mountain summit at Divide (3723 ft.), and a fall of 3705 ft. from Divide to the terminal at Prince Rupert (31 ft.). For operating, the line is divided into 14 divisions, or train districts, and the characteristics of these are shown in the accompanying table.



PLAN AND PROFILE OF THE WESTERN SECTION OF THE GRAND TRUNK PACIFIC RY.

The remarkable feature of the profile and the location is the low grade secured through the Rocky Mountains, this being 0.4%, with the exception of a 20-mi. pusher grade of 1%. For the entire line the maximum grade is 0.4%, with an aggregate of a little over 100 mi. of 0.5%. The latter grades are against westbound traffic only, and the heavier traffic will be eastbound. The 1% pusher grade (against eastbound traffic) is on division No. 9. The changing character of the country is indicated by the change in curvature. For the first five divisions from Winnipeg (to Wainwright, 670 mi.) the maximum curves are 3°. For the next two divisions (to Edson, 250 mi.) this is increased to 4°, while on all the remaining seven divisions, 825 mi. to the coast, the maximum curvature is 6°.

The maximum elevation above sea level is 3723 ft. at the Continental Divide, in the Yellowhead Pass. About 30 mi. beyond this, along the Fraser River cañon, comes the sharp fall of the 20-mi. pusher grade. There is also a summit elevation of 3560 ft. at Obed, on the same division. The Canadian Pacific Ry. reaches an elevation of 5330 ft. at Stephen and 4330 ft. in the Rogers Pass, with grades of 2.2% in both cases (originally 4.2%). The Canadian Northern Ry. will use the Yellowhead Pass, and practically parallel the Grand Trunk Pacific Ry. for about 250 mi. from Edmonton.

The railway has been provided mainly with permanent structures, but there are a few wooden bridges of comparatively temporary nature which will be filled from time to time. There also remains the construction of additional stations, section houses and similar facilities as these become necessary with the development of the traffic. Division points, with the exception of that at Prince Rupert, have all been supplied with roundhouses, shops, coal- and water-handling plants, etc. The railway is in good condition for traffic, but (as on all new lines) considerable additional ballasting will be required where settlement occurs. This work will be done from time to time, and a further lift of ballast will be given over the entire line after traffic has thoroughly settled the roadbed.

At Prince Rupert, the Pacific port, temporary facilities have been provided for railway terminals and dockage. A very ambitious layout is contemplated for railway and water terminals, but it has been thought desirable to make extensive studies before commencing such an undertaking, and this preliminary work is still under consideration.

CHARACTERISTICS OF THE GRAND TRUNK PACIFIC RY., CANADA

Train District	Elev. Above Sea Level, ft.	Miles	Ruling Grade, Per Cent. Westbound Per Cent.	Mi.	Eastbound Per Cent.	Mi.	Max. Curve, Level, Mi.	Max. Curve, Deg.
1. Winnipeg (785 ft.) to Rivers	1568	142	0.5	17	0.4	1	36	3
2. Rivers to Melville	1812	137	0.5	14	0.4	18	26	3
3. Melville to Watrous	1782	129	0.5	19	0.4	35	10	2
4. Watrous to Biggar	2150	118	0.5	27	0.4	19	15	3
5. Biggar to Wainwright	2252	140	0.5	27	0.4	30	22	3
6. Wainwright to Edmonton	2203	125	0.4	29	0.4	35	20	4
7. Edmonton to Edson	2984	128	0.4	48	0.4	16	13	4
8. Edson to Jasper	3460	104	0.4	38	0.4	26	14	6
9. Jasper to McBride	2360	107	0.4	20	0.4	37	22	6
	pusher		1.0		1.0	20		
10. McBride to Prince George	1870	144	0.4	18	0.4	36	32	6
11. Prince George to Endako	2245	116	0.4	24	0.4	7	36	6
12. Endako to Smithers	1640	127	0.4	4	0.4	28	26	6
13. Smithers to Pacific	385	105	0.4	4	0.4	67	15	6
14. Pacific to Prince Rupert	31	120	0.3	1	0.4	11	72	6

Sea Water to Rise into Fresh-Water Canal

By Paul Whitham*

In *Engineering News*, Nov. 26, 1914, p. 1088, there was an editorial commenting on the salting of Miraflores Lake on the Panama Canal as a "curious hydraulic paradox."

At Seattle, Wash., what is known as the Lake Washington Canal is now approaching completion. The community had always supposed that the water above the locks would be fresh, being fed by the overflow from Lakes Union and Washington, both fresh-water bodies. The unexpected invasion of Miraflores Lake by the sea water led to the belief that a similar condition would prevail at Seattle when the canal and lock are put in operation. The phenomenon is of such interest that it invites an analysis of the reasons therefor and the drawing of a parallel between the two cases.

Briefly, the conditions at Panama are as follows: The Miraflores locks are located about 8 mi. inland from

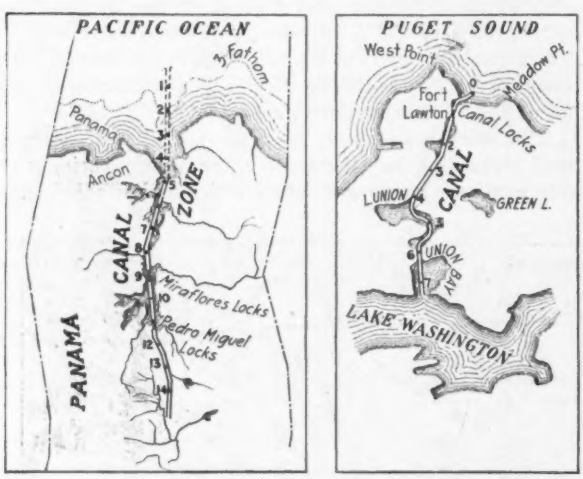


FIG. 1. PACIFIC END OF THE PANAMA CANAL AND THE LAKE WASHINGTON CANAL TO THE SAME SCALE

the Bay of Panama. The extreme tidal range is approximately 20 ft. Miraflores Lake, an irregular body, is about 2 mi. in its greatest length. The surface of the lake is 55 ft. above mean tide in the Pacific, and the bottom of the lake is above high tide in the sea-level section of the canal.

There are two pairs of locks, each 110x1000 ft., dividing the lift into practically two parts. By February, 1914, samples taken showed a diffusion of salt throughout the whole lake, the proportion of salt water running as high as 15 per cent. This necessitated the abandonment of Miraflores Lake as the source of domestic water-supply.

The conditions in Seattle are substantially as follows: The lock is located about a mile inland from the main body of Puget Sound. Salmon Bay, immediately above the lock, is a basin over a mile in length. Lake Union, approximately the same area as Miraflores Lake, begins about 2½ mi. above the lock. A canal connecting the two bodies is nearly 1½ mi. long. The extreme tidal range is approximately 17 ft. The surface of Salmon Bay, which will become a basin or lake, will be about 16½ ft. above mean tide, or only 8 ft. above high tide. The bottom of the basin will be from 24 to 32 ft. below high tide. The lock is 80x825 ft., there being but one lift.

From appearance the conditions here tending to pass sea water through the lock are decidedly more favorable than at Panama. At first thought one might look upon the statement that sea water will pass up the lock as an assertion that the law of gravity will be reversed by making water run uphill. When analyzed, however, the action is shown to be the result of natural laws, explained as follows:

Assume that a vessel enters the Seattle lock from the sea at mean tide. The depth of the water in the lock would be 33½ ft., not less than 80 per cent. of which probably would be salt water. Fresh water from above would then be let in at the bottom of the lock, which action should mix the fresh and salt water during the process of increasing the depth to 50 ft. The resultant mixture would then be approximately 60 per cent. of salt water.

Sea water may be said to weigh 64 lb. per cu.ft. and fresh water, 62.5 lb., a difference of 1.5 lb. The 60 per cent. salt water would consequently weigh 0.90 lb. per cu.ft. more than the fresh water, so that in the lock at a depth of 1 ft. below the surface there would be a head of 0.90 lb. per sq.ft. over that of the fresh water above the lock. On the upper sill, 36 ft. below the surface, the difference in weight would be 32.4 lb. per sq.ft., the equivalent of over 6 in. of head. When the upper gate is opened to let the ship into Salmon Bay this difference in head will be sufficient to cause the brackish water to flow out of the lock with an initial head of 6 in. along the bottom of the basin, while the fresh water will flow in from the top and take its place. When this heavy sea water has spread out and fallen half the distance there will still be a 3-in. head, which should be sufficient to produce a strong current of large volume, considering the resistance encountered in a wide channel. This difference in head operates in principle much the same as a common hot-water heating system, in which a slight difference in head created by the variation of temperature of the water in the up and down pipes is sufficient to produce a positive circulation against the high resistance of small piping.

Unless artificially disturbed, the salt water will tend to spread over the bottom of Salmon Bay and along the canal to Lake Union in wedge-shape form, thus losing head. The movement of boats, the churning of their propellers, and other causes will gradually diffuse the waters of the basins and canal until the entire body becomes brackish. The effect of this stirring up of the water would be mechanically to lift the salt, distributing it all the way up to the surface.

To illustrate: Take a point at some distance above the lock and assume that the 60 per cent. sea water has filled the bottom of the channel to one-fourth the depth, or 9 ft. This would be equivalent to a head of 1½ in. at the bottom of the channel. When the water is thoroughly stirred up, there still would be a 1½-in. head at the bottom, the salt creating the head having, however, a greater elevation—that is, the plane of mean head would be raised from 4½ ft. above the bottom to 18 ft., greatly increasing the volume of water tending to displace the fresh water further up.

*Consulting Civil Engineer, Seattle, Wash.

The effect would be that of having mechanically stored up energy by lifting the weight the additional height, the result being a progressive acceleration of the salt water up the canal and its distribution throughout the basins.

The lower temperature of the sea water—the difference between it and the lake water being quite appreciable in the summer—would tend to increase the effective head.

Practically there is a serious side to the salting of Salmon Bay and Lake Union. It is not known how salty the water will become, or whether it will sufficiently approach the condition of sea water to sustain the life of the teredo, or wood borer, that infests Puget Sound waters. In case it did, however, prevent the use of untreated timber piling it would frustrate one of the important benefits expected of the canal lock.

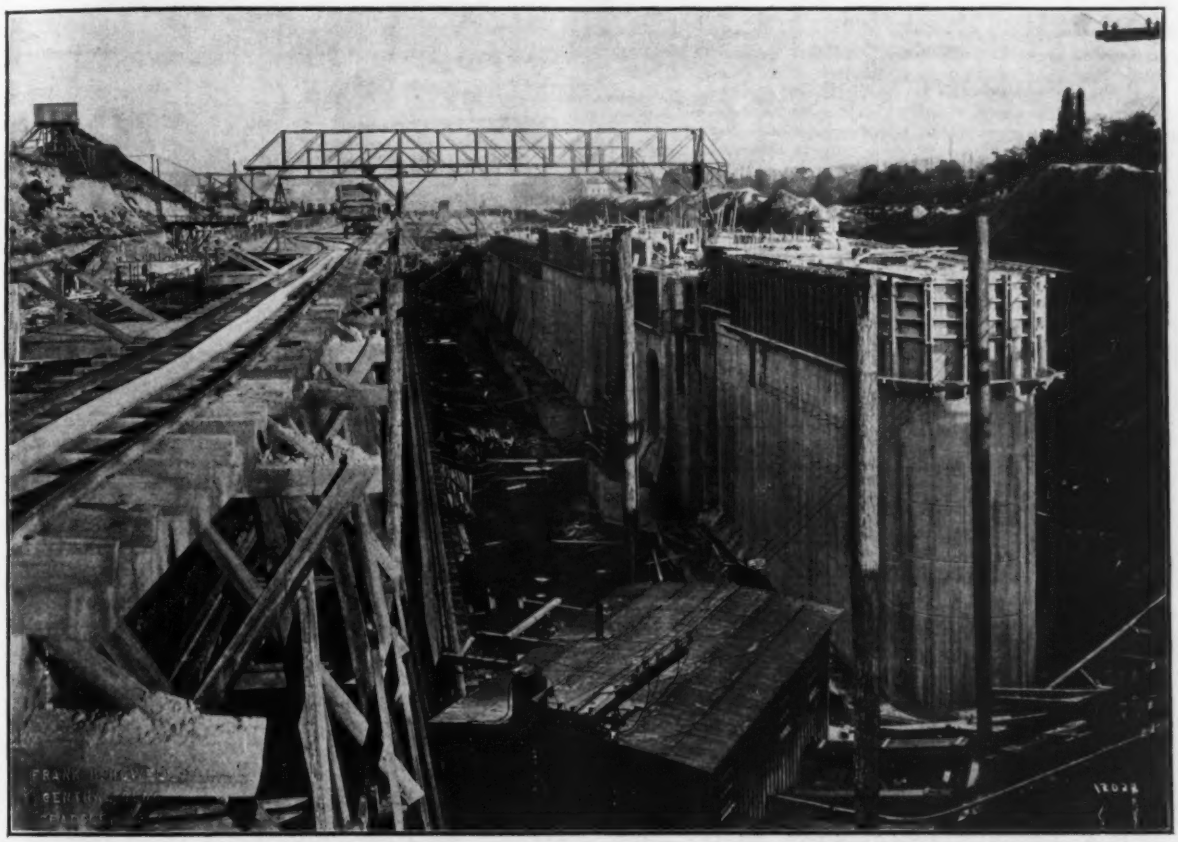


FIG. 2. LAKE WASHINGTON CANAL LOCK UNDER CONSTRUCTION

Industries have already located or purchased sites about Salmon Bay and Lake Union, anticipating the advantages they would enjoy in obtaining fresh water direct from the canal and lakes for manufacturing purposes. The salting of the water will wipe out the expected benefits.

It has been predicted that the fresh-water harbor would become the haven of vessels laid up when out of commission, where they would not be subject to the rapid accumulation of barnacles and other sea growths. Also, in the case of steel vessels, the chemical and galvanic corrosion would be much less in fresh water. These expected advantages, particularly the last-mentioned one, would be endangered by the salting of the water.

J. B. Cavanaugh, Corps of Engineers, U. S. A., is looking into the practicability of preventing or reducing in some manner the passage of salt water through the lock.

Engineers and Public-Service Commissions

In *Engineering News*, Apr. 29 (p. 842), were published suggestions formulated by a committee of engineers representing the national engineering societies for submission to the New York State Constitutional Convention. This general committee of engineers has since organized subcommittees to deal with the various subjects covered in its recommendations. The Subcommittee on Public Utilities has formulated and had introduced into the convention, through the courtesy of Prof. O. H. Landreth, of Schenectady, a member of the convention, a constitutional amendment (No. 708) reading as follows:

Article five of the constitution is hereby amended by adding a new section thereto, to be appropriately numbered, to read as follows:

A public service commission of five members shall be appointed by the governor by and with the advice and consent of the senate. Each commissioner shall hold office for ten years. The terms of the commissioners shall be so arranged that the term of one member shall expire upon the first day of February in alternate years. Each commissioner should have had experience in connection with public utilities which would fit him for the duties of the office.

The commission shall regulate and supervise all common carriers, all water supply, irrigation, drainage, gas, power, lighting, heating, intelligence-transmitting and other public utility corporations operating within the limits of New York state, including similar activities on the part of any other state department or political subdivision of the state.

Removal by the governor of any commissioner should be made only after the filing of charges and after affording the accused an opportunity to be heard in the matter, provided, however, that at any time within the first six months after making an appointment the governor may exercise the power

of summary removal. A successor to a commissioner who has been removed should be appointed to fill the unexpired term.

Vacancies caused by removal or otherwise should be filled under conditions similar to those governing original appointment.

The engineers' Subcommittee on Public Utilities, in order to support this amendment, has forwarded a statement to the chairman of the Constitutional Convention's Committee on Public Utilities, Hon. L. P. Hale. The statement is as follows:

The Subcommittee on Public Utilities of the General Committee representing national and local engineering societies, which has already memorialized the Convention respecting the changes they desire to see incorporated in the New York Constitution, respectfully submits the following:

The thing which we consider of greatest importance in any plan for organization of a State Public Utility Commission is the preservation of the principle of continuity, already established in the present Public Service Commissions.

By this we refer to the system whereby the term of office of the members of the Commission expire at different times, so that only one member of the Commission at a time goes out of office. Under this plan, a new member has the advantage of association with colleagues who have had years of experience in the work. Thus the plans, policy and methods of the Commission are continued with only such gradual change as experience may develop, and without the delays and unnecessary and at times undesirable changes which would be certain to occur if the entire membership of the Commission were changed at one time.

Experience has proved also that under this form of organization, the staff of the Commission is a permanent body. It can readily be understood that with the great responsibilities laid upon the Public Service Commission, the members of the Commission must devote their time to questions of general policy and the detail work must be done by the Commission's staff of engineers, attorneys, accountants, etc. The character of the work done by the Commission will depend very much on the sort of men it secures for its staff, and it can secure very much better men if those appointed hold their positions continuously as long as they display ability in the discharge of their duties.

If, however, a change were to be made in the public service law so that an entirely new commission would be appointed with each new gubernatorial administration, there would be danger not only that the commissioners would be appointees without the experience and knowledge necessary to formulate and carry on a sound constructive policy, but that the principal employees of the Commission would be changed for political reasons with the coming in of each new Commission.

QUALIFICATIONS OF COMMISSIONERS

The second important thing that we would urge upon your honorable body is the embodiment of some provision in the constitution setting forth the qualifications which candidates for the position of Public Service Commissioner should possess.

There is no doubt that state and federal control of those monopolies generally known as public utilities is here to stay; but it is a serious question whether these great powers of control will be so wisely and justly exercised that on the one hand the public will be satisfied and on the other hand the public utility corporations may be able to continue in business and meet the requirements made upon them.

The vast responsibilities placed upon these Public Service Commissions are hardly realized as they should be. Upon their proper handling of the very difficult questions before them, depends the welfare, the prosperity, the safety of millions of people.

It is unfortunately the case that many of the appointments to state public service commissions have been of men who had not sufficient experience or ability properly to fill these positions. We have, therefore, proposed for incorporation into the Constitution the requirement that any man appointed to membership in the Public Service Commission "should have had experience in connection with public utilities which would fit him for the duties of his office."

The questions which come before a Public Service Commission require for their intelligent decision intimate acquaintance with technical matters, financial matters, commercial matters, legal matters. There can be no question that men who are already familiar with matters of this sort from experience in the management of public utilities, can render much more valuable service in the control of these utilities than men who are without such experience.

There are to be found among those connected with public utility companies men with as broad conceptions of public rights and of the duties to be fulfilled to the public as can be found in other walks of life. We believe that such experienced men, knowing well what can be done and what cannot be done, would be able to deal more firmly with the companies than would members of a commission who lacked such technical experience.

It should be understood, moreover, that the constitutional requirement we have suggested—previous experience in connection with public utilities as a requisite to a commissioner's appointment—is not to be construed as a rigid limitation upon the governor's discretion in making appointments. The responsibility would properly be upon the governor to judge as to how much experience was requisite to fit a candidate for appointment. The value of such requirements, embodied in a statute or a constitution, is that they define the requirement which the governor should have in mind in the selection of candidates. It is not pretended that this requirement or any other which could be framed could prevent the selection of unfit candidates. It is believed that such clauses are of value, nevertheless, in setting up a standard to which most men in the long run will seek to conform.

The third important feature of our recommendation is that there should be one Public Service Commission for the whole state instead of two as at present. If your honorable body shall see fit in its discretion to provide for the perpetuation of the principle of continuous organization in the control of public utilities, and shall provide that public service commissioners shall have had previous experience which would fit them for the duties of their office, the main purposes of our committee will have been accomplished.

New Carquinez Straits High-Tension Crossing

The Pacific Gas & Electric Co., of San Francisco, has recently added two aërial cables across the Straits of Carquinez as part of the high-tension lines from its mountain power-houses to Oakland. The first cables of this crossing were slung 14 years ago, when the Bay Counties Power Co. completed its 142-mile transmission system from Colgate (as described at length in *Engineering News*, Oct. 3, 1901).

For this pioneer work no precedents had then been established. The main span was 4427 ft. and the cables were 20 ft. apart horizontally and vertically, as shown in Fig. 2. All four cables were anchored to a buried concrete block at each end; they passed over one leaning and two vertical towers, and were held at 208-ft. minimum distance above the water. Each tower saddle was formed by a five-sheave frame on a wood structure supported by six porcelain insulators and three wooden cross-arms (see Fig. 2). At the anchorages two housed strain insulators were placed between each cable and the concrete block. The strain insulators were iron frames with micanite barriers in oil-filled cylinders, as shown in Fig. 7.

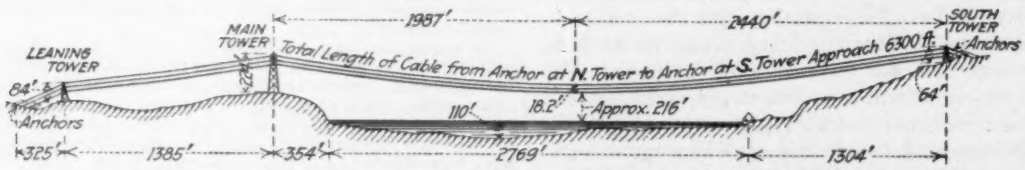
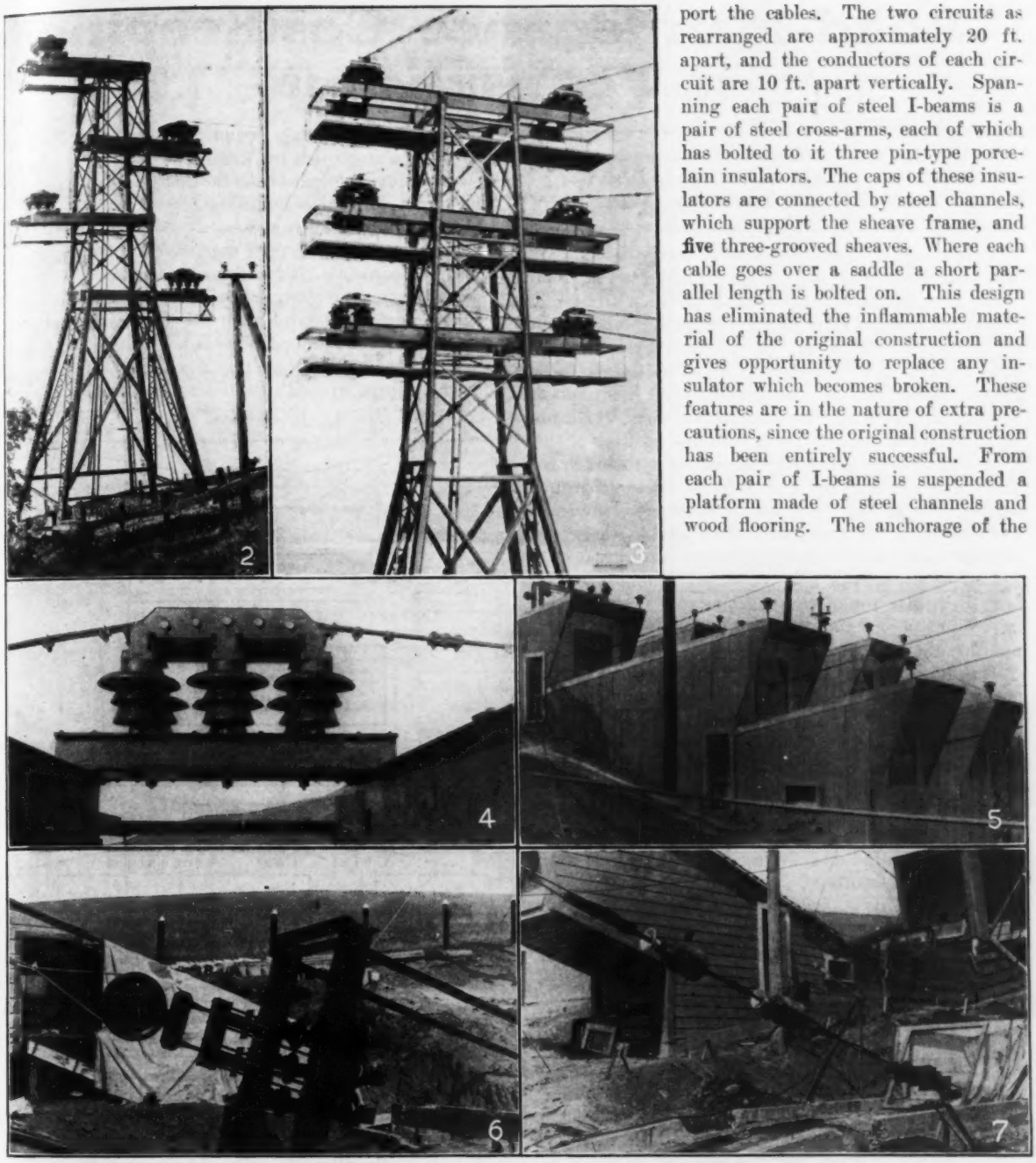


FIG. 1. THE REBUILT CABLE SPANS ACROSS THE STRAITS OF CARQUINEZ, CALIFORNIA



port the cables. The two circuits as rearranged are approximately 20 ft. apart, and the conductors of each circuit are 10 ft. apart vertically. Spanning each pair of steel I-beams is a pair of steel cross-arms, each of which has bolted to it three pin-type porcelain insulators. The caps of these insulators are connected by steel channels, which support the sheave frame, and five three-grooved sheaves. Where each cable goes over a saddle a short parallel length is bolted on. This design has eliminated the inflammable material of the original construction and gives opportunity to replace any insulator which becomes broken. These features are in the nature of extra precautions, since the original construction has been entirely successful. From each pair of I-beams is suspended a platform made of steel channels and wood flooring. The anchorage of the

FIGS. 2 TO 7. DETAILS OF OLD AND NEW CONSTRUCTION AT CARQUINEZ STRAITS

Fig. 2—Old south tower. Fig. 3—New south tower. Fig. 4—New saddle. Fig. 5—New anchor houses. Fig. 6—New anchor and strain insulator. Fig. 7—Old strain insulator and anchor

The new cables, which are duplicates of the old ones, are 7/8 in. in diameter and consist of 19 strands of galvanized plow-steel wire. They have a total ultimate strength of 48 tons, equivalent to 215,000 lb. per sq.in.; the normal load stress is about 11 tons on each cable. The cables were furnished in single pieces 6300 ft. long.

To accommodate the two new cables the tower tops had to be reconstructed. The old wooden cross-arms were discarded for three pairs of steel I-beams overhanging the sides of the towers, as shown in Fig. 3. Near the ends of these steel-beam arms are the saddles which support the two new cables shows somewhat the same ideas in design. Two latticed-channel steel beams are set up in the concrete block foundations, inclined with their tops backguyed into the blocks. On each of these beams are three pin-type porcelain insulators, with two caps cross-connected by horizontal double-channel cross-bars. Across these bars in turn and parallel with the main beams are other channels, with rods leading to the spring frame of the sheave around which the crossing cable is wrapped (see Fig. 6). All the anchors are covered with corrugated-iron houses, the cables entering through plate-glass windows.

Road-Maintenance Costkeeping in Pennsylvania

SYNOPSIS—Organization of maintenance division of Pennsylvania State Highway Department and the method of keeping costs on repairs.

It is always debatable how far the compiling of records and cost data should be carried. Elaborate costkeeping systems as safeguards in the expenditure of the people's money are perhaps more justified on public works than on private works. Moreover, the collection of elaborate records and cost data of operations which bid fair to become interminable, such as maintenance work on highways, is more justifiable than for construction work, which when once completed is of no further interest in itself.

The advantages generally claimed for a thorough costkeeping system are that it gives to the lowest laborer and foreman filling out their daily reports more interest in and knowledge of their work than might otherwise be the case; and that a proper study and utilization of the reports—from laborer up—condensed, compiled and systematized, give the office management a desirable check on field operations and data of value for future estimates, and for other purposes.

The disadvantages of too elaborate a system are that generally a good foreman or fieldman is a mighty poor clerk, and vice versa. The time spent in filling out multitudinous blanks of green, pink, yellow and white paper might perhaps be otherwise employed in building or repairing roads. The petty annoyances that the head office may cause an honest, well-intentioned foreman who makes mistakes, which, considering the man's characteristics, are perfectly excusable, has driven many a man to drink, or to something worse.

Hence, with these considerations in mind, in presenting here a brief outline of the record and costkeeping system of the Pennsylvania State Highway Department, it is not the intention to hold up a model of excellence but to show how far, at least, one state highway department has gone in collecting, compiling, tabulating and analyzing cost data on road maintenance. There is another purpose, and that is to give an outline classification of highway work, which could be made of great use in an engineer's library as the basis of an index and classification system—as detailed perhaps as has yet been attempted.

Organization of Maintenance Division

The maintenance and repair work on state and state-aid highways in Pennsylvania is handled by a division of the State Highway Department separate and distinct from that handling new construction. Day laborers are employed and paid directly by the state, which is divided into districts in charge of engineers under whom are superintendents, general foremen, foremen and laborers. General supervision, engineering and executive work are done by a maintenance engineer through his assistant engineers and chief clerk. Fig. 1 is a classification and diagram of the work and Fig. 2 is an organization chart.

The origin of all data is with the foreman directly in charge of the work, who in his Daily Report furnishes to his general foreman a complete statement of the number of men employed, the number of hours and the rate per hour for each man, with the charges distributed over the various operations under the proper heading. His report shows the location and extent of all work performed.

At the end of each week the general foreman, upon a General Foreman's Weekly Report, furnishes the superintendent with a summarized statement of work performed in his district, compiled from the Foreman's Daily Reports. A rearrangement of charges eliminating the individual laborer places all the data in the form required for the Superintendent's Semi-Monthly Progress Report,

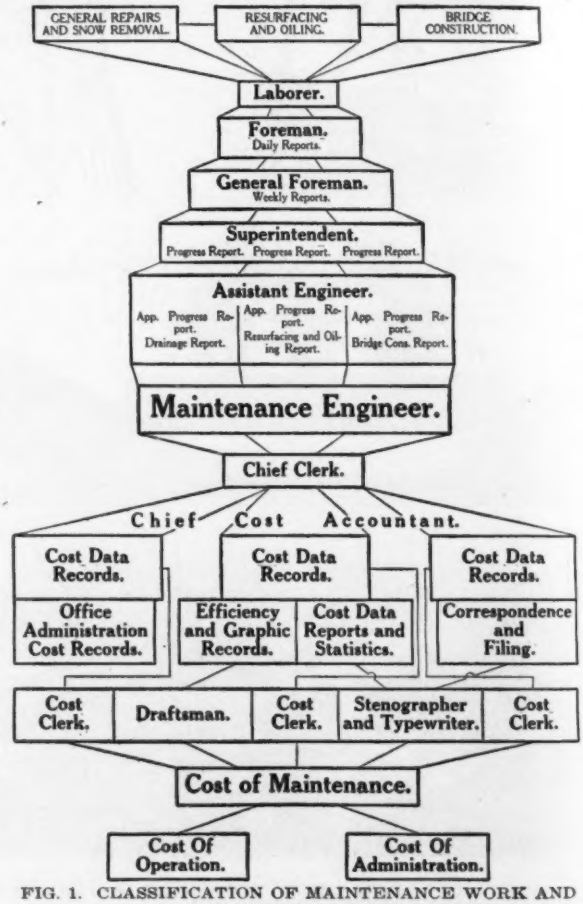


FIG. 1. CLASSIFICATION OF MAINTENANCE WORK AND METHOD OF HANDLING

which accompanies all payrolls, and enables him to readily summarize all costs.

The pay periods for all classes of employees paid on an hourly basis close on the 15th and last day of each month, and at this time the superintendent forwards to the assistant engineer all payrolls, with progress reports, showing distribution of all charges appearing on the payrolls. Through the assistant engineer, after the necessary checking and recording have been done, the payrolls are forwarded to the offices of the Maintenance Division, where they are thoroughly checked for correct distribution of costs and for consistency.

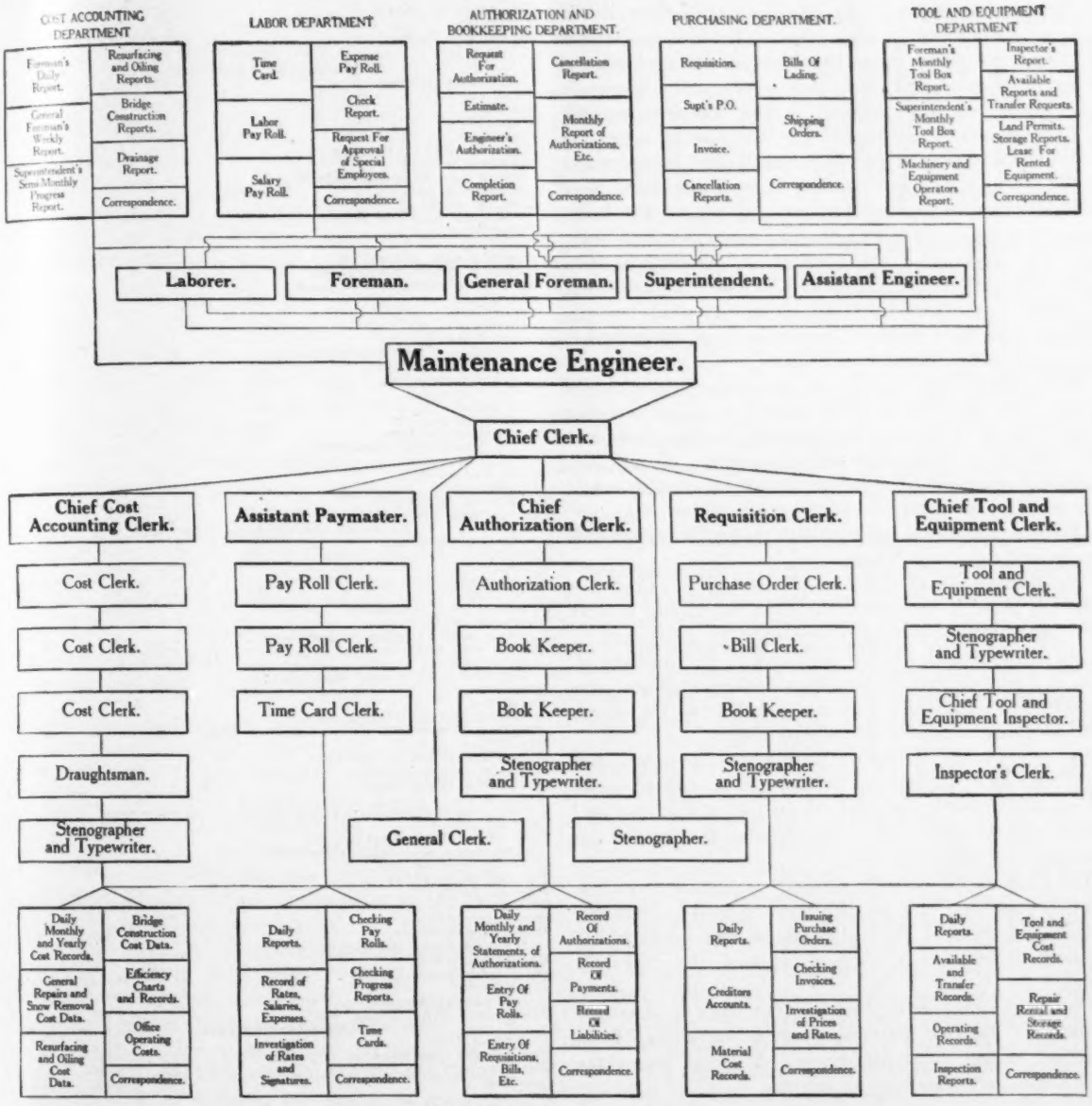


FIG. 2. ORGANIZATION CHART OF MAINTENANCE DIVISION OF THE PENNSYLVANIA STATE HIGHWAY DEPARTMENT

The method of classifying expenditures for material, supplies, rentals, salaries, expenses, etc., is similar to the method used in classifying labor expenditures—all bills presented being accompanied by progress reports, with the cost charged to the proper operation.

A list of the various forms (all made out in duplicate and some in triplicate) which originate or pass through the hands of the superintendents and assistant engineers follows:

85-H Department Authorization.
85-J Application for Authorization (Superintendent).
85-I Engineer's Authorization.
893 Requisition.
892 Department Purchase Order.
892½ Shipping Order.
894 Bill Heads.
Department Bill of Lading.
Department Memorandum Bill of Lading.
Identification Card (Engineers).
83 Time Card.
84 Foreman's Daily Report.
81-E Roller and Crusher Daily Report.
81-D Motor Truck Daily Report.
890 Time Book.
891 Superintendent's Purchase Order.
90 Superintendent's Report (Personal Weekly).
87 General Foreman's Weekly Report.
85 Payroll (Labor and Team).
85-C Payroll (Superintendent's Bill).
85-D Payroll (General Foreman).
85-F Payroll (Monthly Employees).
85-E Payroll (Monthly Employees' Expense).
86 Semi-Monthly Progress Report.
85-A Summary Sheet (Payroll).
898 Superintendent's Check Report.
85-K Report of Completion of Authorization.
81-C Receipt Book.
80 Superintendent's Salary Receipt.
80-A Monthly Employees' Salary Receipt.
895 Monthly Resurfacing Report (Water-bound macadam).
896 Monthly Resurfacing Report (Bituminous macadam).
897 Monthly Drainage Report.
900 Assistant Engineer's Monthly Maintenance Report.
88 Superintendent's Monthly Tool Report.
89 General Foreman's Monthly Tool Report.
9-D Land Lease.
10-A Resolutions, Board of Supervisors, for maintenance and repair of state-aid roads, agreeing to pay 50 per cent. of the same.
10-B Resolutions, Borough Council, for maintenance and repair of state-aid roads, agreeing to pay 50 per cent. of the same.
904 Annual Bridge and Culvert Report.
Traffic Census.

It is not necessary to go into the use of these in detail, as their titles and the charts, Figs. 1 and 2, are sufficient to make somewhat clear their applications. Some description of their contents, however, is essential. The requisition form requires a very complete analysis of the proposed expenditures. The detail progress reports, payrolls, and special reports on resurfacing, bridge work, traffic censuses, etc., are familiar to most engineers; they naturally require considerable time and labor. The Land Lease, 9-D covers all rentals of quarries, storage buildings, etc. The forms 10-A and 10-B are for agreements with local road authorities. It should be added that the list of forms given here has since been somewhat revised, extended and elaborated. These, it is to be remembered, are reports originating in the field.

In the office, checking reports for consistency of classification and operation is given careful attention, and the location of the work as shown upon the reports is checked with records of the maintenance engineer's office, which have been compiled from the surveys of the various roads and which show accurately stations for all township borough and county lines, together with the location of all improved and constructed roads.

The records are then taken in hand by the Cost Accounting Department under the chief clerk, and several dozen more blanks varying in size from an index card to sheets about 24x30 in. are filled out. The amount of data and general information thus accumulated and systematized is remarkably full and complete as the classification given herewith will make clear.

In the accumulation and compilation of these data, the route number or application number (in the case of state-aid roads), which is the legal designation of the road under the state-highway acts, is considered as the unit for the separation of all such costs.

The Cost Accounting Department is furnished with a monthly statement of expenditures upon each route under each classification by the Authorization and Bookkeeping Department, which is checked against the cost-data records.

Upon all routes or applications the work is classified as follows: General Repairs, Resurfacing, Bridge Construction, Oiling, Removing Snow. A list of the operations under each classification follows:

GENERAL REPAIRS

Superintendence
Removing loose stones, dirt, etc.
Filling ruts and washouts
Repairing gutters and berms
Dragging
Scraping and crowning
Excavating gutters
Grubbing and clearing
Grading (cuts and fills)
Quarrying and stripping
Crushing
Hauling stone and screenings
Spreading stone and screenings
Loading and unloading stone
Hauling and laying telford
Cost of stone
Removing snow
Cleaning and repairing drains
Repairing timber bridges
Repairing stone bridges and culverts
Repairing concrete bridges and culverts
Placing pipe drains
French drain
Tile drain
Scarifying
Sprinkling
Rolling
Erecting and maintaining guard rail
Handling equipment
Temporary bins, sheds, etc.
Patching and repairing asphaltic concrete
Patching and repairing asphalt and penetration macadam
Repairing brick road
Dry rubble masonry
Rubble masonry (mortar)
First class masonry
Concrete masonry
Cribbing
Repairing tools.

RESURFACING

Waterbound Macadam

Bottom course:
Grading
Rolling
Quarrying
Crushing
Loading and unloading
Hauling telford
Laying and napping telford
Berms and gutters
Cost of stone

Second and top course:
Quarrying
Crushing
Loading and unloading
Hauling stone, screenings
Spreading stone, screenings
Scarifying
Sprinkling
Rolling
Cost of stone

Drainage and miscellaneous:
Placing pipe drain
Placing box drain
French drain
Tile drain
Repairing drains
Repairing bridges
Catch basins and headwalls
Retaining walls
Supertintendence
Timekeeper
Handling equipment
Temporary bins, sheds, etc.

Asphaltic bituminous macadam

Bottom course:
Grading
Rolling
Quarrying
Crushing
Loading and unloading
Hauling telford
Laying and napping telford
Berms and gutters
Cost of stone

Second course and seal coat:
Quarrying
Crushing
Loading and unloading stone
Hauling stone and screening or mixing and hauling mixture
Scarifying
Spreading stone or mixture
Heating and pouring
Spreading screenings
Rolling
Hauling and spreading stone chips or torpedo sand
Cost of stone
Cost of mixture aggregate

Drainage and miscellaneous:
Placing pipe drains
Placing box drains
French drain
Tile drain
Repairing drains
Repairing bridges
Catch basin and headwalls
Retaining walls
Superintendence
Timekeeper
Handling equipment
Temporary bins, sheds, etc.

Asphaltic concrete

Foundation:
For telford (as above)
For concrete (as follows)
Grading
Rolling
Quarrying
Crushing
Loading and unloading
Hauling materials for mixing
Placing materials
Berms and gutters
Cost of stone
Cost of sand
Cost of cement

Asphaltic concrete course:
Quarrying
Crushing
Loading and unloading
Mixing and hauling
Spreading mixture
Rolling
Spreading screenings

Seal coat:
Heating and pouring
Hauling and spreading chips or torpedo sand
Rolling

Drainage and miscellaneous:
Placing pipe drains
Placing box drains
French drain
Tile drain
Repairing drains
Repairing bridges
Catch basin and headwalls
Retaining walls
Superintendence
Timekeeper
Handling equipment
Temporary bins, sheds, etc.

BRIDGE CONSTRUCTION

Equipment
Excavating channel

Temporary traffic
Fencing
Guard rail
Approaches
Excavating for foundation
Coffer-dam
Erecting forms and falsework
Removing forms and falsework
Materials for forms and falsework
Hauling materials for concrete
Mixing and placing concrete
Facing concrete
Cost of aggregates
Reinforcing bars, rods, I-beams
Expanded metal
Superintendence
Timekeeper

OILING

Surface
Sweeping, filling holes, etc.
Oiling (heating and distribution)
Hauling sand or screenings
Spreading sand or screenings
Rolling
Loading
Drainage and miscellaneous:
Superintendence
Timekeeper
Handling equipment
Temporary bins, sheds, etc.

As a means of readily identifying all accounts presented, each authorization is characterized by a serial letter and number as follows:

STATE HIGHWAY

Serial Letter	Serial Number	Classification
G	1-3000	General repairs
R	3001-4000	Resurfacing
O	4001-4500	Oiling
B	4501-5000	Bridge Construction
S	5001-6000	Removing snow
T	6001-7000	Purchase of tools and equipment
E	7001-8000	Repairs to equipment
Y	8001-8500	Storage

STATE AID

A	8501-9000	General repairs
A	9001-9500	Resurfacing
A	9501-9750	Oiling
A	9751-10000	Removing snow.

All accounts presented, whether labor, material, supplies, etc., show the authorization number in addition to the route and county to which they are charged. Under this system the actual cost of any special work, such as resurfacing, oiling or bridge construction—also the yearly maintenance cost on any piece of improved or constructed road—is readily obtainable; and valuable data on the maintenance cost of the various types of constructed roads are compiled from year to year.

Upon the completion of special work on any route or application, the Cost Accounting Department furnishes a detailed cost data report, showing location, character and extent, together with information such as rates paid the various classes of labor, price of material, length of haul, etc. By referring to this cost-data record at any time a specific operation on any road can readily be determined, including the exact location and extent and the elements of labor and material which have entered into the work. Yearly cost-data reports showing in detail the cost of general repair operations on every route or application are also compiled.

In addition to the yearly cost-data report, an accumulating graphic record, devised to cover a period of years showing the location, character, extent and cost of each classification of work upon every road in the form of a map, is compiled.

The Purchasing Department of the Maintenance Division keeps a record of the prices paid for all material, supplies, etc., which are embodied in the reports furnished by the Cost Data Department. Detailed records of the cost of tools and equipment and repairs, showing comparative costs in the different districts of the state, are kept in the Tool and Equipment Department of the division.

The most conspicuous feature of the work done in the office is the daily summary sheet, which every day gives the maintenance engineer a complete record of the work in each and every road district to date, the kinds of work, purchases made and authorized, payrolls passed, the amount of the appropriation and the part of the appropriation expended to date. This summary is elaborate and keeps the head of the department in intimate and constant touch with the work in all parts of the state. Then, there are similar but still more elaborate weekly and monthly summaries.

The foregoing is merely an outline, which may be used by the reader for a variety of purposes. To attempt to describe in detail the various operations and methods of costkeeping in use in Pennsylvania is beyond the scope of such an article.

The engineer of maintenance of the Pennsylvania State Highway Department who has worked out the system described is George H. Biles, who was recently appointed Deputy Highway Commissioner, with Robert J. Cunningham as Commissioner and W. D. Uhler as Chief Engineer.

Barge Canal Navigation Aids*

So much of the new Barge Canal of the State of New York is in rivers or lakes that it has been necessary to place various aids to navigators, such as buoys, beacons and range towers, which carry lights by night and show where in the expanse of river and lake lies the navigable channel. The localities to be thus buoyed and lighted require a total of about 550 buoys and 300 stake lights, together with about a dozen lighthouses.

The system of marking adopted is to use two buoys on the inside and one on the outside of each curve. The buoys on the inside of the curve are placed at the beginning of the curve, the buoy on the outside is placed opposite the middle of the curve. These buoys and their lights, with a few along the tangents, have been found to be very satisfactory. In addition to buoys and stake lights, long tangents are marked by a pair of range lights placed on shore in line with the prolonged center line of the canal. The rear range light is set higher than the front light, so the navigator will be on the correct center line if he keeps his craft in such a position that the two range lights appear in a vertical line, one above the other.

To meet another need of the navigator of the new canal there have been issued charts covering sections of river channel. On these charts are located all of the beacons, buoys, spars, bridge lights, range towers and lighthouses which mark the course and also explanation is given of the colors the various markers are painted, as well as the colors of the lights they display at night. Upon the charts are shown the river banks and the topographic features of the adjoining land for several hundred feet on either side, together with the names of inflowing streams, islands, villages, railways and the like. There appear also tables of distances.

The buoys and beacons which show red lights are painted red, while those showing white lights are painted black. The range towers have white lights, the channel rims at bridges are marked by red lights and the centers of lift-bridges show red lights when the bridges are closed and green lights when they are open.

*From the "Barge Canal Bulletin," June, 1915.

Large Coaling Stations on the Panama Canal

SYNOPSIS—At each end of the Panama Canal there is being erected a large coaling station of special design, for supplying fuel to passing steamers. This article describes the two designs.

The huge coaling stations at the Atlantic and Pacific terminals of the Panama Canal, which are to be completed during 1916, have unusual interest because of their size and equipment. The main station is located at Cristobal on the Atlantic side, since it is on this sea that the coal supplies are borne. The Cristobal plant is designed to meet all the military, commercial, railway and canal requirements; the Balboa station will probably handle little commercial coal. Except for the military necessity of an independent and additional supply on the Pacific end, the second station at Balboa probably would not have been built at this time. At both stations large underwater storage space has been provided for the permanent storage of coal without deterioration or danger of spontaneous combustion.

FIG. 1. BIRD'S-EYE VIEW OF CRISTOBAL COALING STATION ON THE PANAMA CANAL
Reproduction of a perspective drawing by E. W. Spofford, of New York City

Cristobal Station

The Cristobal plant consists essentially of a pier about 1825 ft. long and some 420 ft. wide. One side of this is designated as the "unloader wharf" and the other side as the "reloader wharf," connected by an "end wharf" with a bunker for tugs and other small craft. For 1065 ft. along the unloader and reloader wharf the bottom is dredged to 41 ft. depth. The southerly part of the pier is considered as a shore extension without waterfront.

The deep-water section of the pier consists of a steel and concrete dock deck supported on 6-ft. concrete cylinders going down from 50 to 75 ft. to solid rock. The cylinders were spaced and the deck frame designed according to the position of the loads. About 5000 tons of structural steel and 18,000 cu.yd. of reinforced concrete were used. The shore extension consists of concrete walls and piers supported by piles.

Between the long wharves is the huge coal pile (resting on natural bottom), with the submerged-storage section at the ocean end. The coal pile is spanned by two stocking and reclaiming bridges which can travel the full length of the pier. There is a steel viaduct, 29 ft. high, around the whole pier, and on this are two separate looped 3-ft.-gage tracks for the motor-operated cars.

On the unloading wharf are four one-man steeple-type towers, with the familiar long booms and a trolley carrying the lines of a grab bucket (2½ tons capacity). Each tower is supported on 16 wheels running on two 3-ft.-gage tracks, laid 24½ ft. c. to c. The combined capacity of the four unloaders is 1000 tons per hour. They are steam operated, and are the only pieces of equipment at the station so operated, all other machinery being driven by electric power. They discharge coal, through hoppers and steam-operated cutoff gates, into motor-driven cars.

These cars are a W-bottom type of 10 tons capacity and are propelled by two 3-hp. constant-speed alternating-current motors at a track speed of 200 ft. per min. The cars are stopped, started and dumped by trackmen stationed at desired points. Otherwise they have no attendants while in motion. The cars travel over a fixed route, and in normal operation no switching is done. Each stocking and reclaiming bridge carries on its lower chord a single track of the electric railway, connected to the viaduct at each end by sliding curves which pick up the cars from the viaduct as they approach the bridge and deliver them back on the other side of the pier. The coal is dumped into storage from this bridge track. For reloading coal two crane diggers are carried on the upper chord of each bridge, discharging into the same cars on the same track as previously noted. The cars

deliver to reloading towers, which replace the large and expensive wharf bunkers provided in most coaling stations.

The stocking and reclaiming bridges are heavy through-span structures, 315 ft. c. to c. of end bearings, and each weighs about 1400 tons equipped. Each end is supported on two 16-wheel trucks with heavy cast-steel bolsters and equalizers. These trucks travel on the standard-gage tracks leading to the Panama R.R. The bridges are propelled by an independent 170-hp. motor at each end; a maximum track speed of 50 ft. per min. is attained. These two motors have separate speed controllers, which are worked by separate handles in the operators' cabs so arranged that they can be moved together or separately. This is necessary in order to keep the bridge square with the rails under all conditions of track and wind load. A large dial indicator shows the amount of variation from square.

The digger machines move along the top chords of the bridges so that they can reclaim coal from the entire storage area. Each has a 5-ton grab bucket swung from a patent boom frame which is hoisted by a cable running over a differential drum so that the grab bucket follows a fixed path in and out. This eliminates the independent trolley or boom engine and fixes the path of the bucket clear of the digger frame. This scheme gives speedy operation with a single attendant, who need have no special skill.

For reloading to boats there are four delivery towers on the reloader wharf, each supported on four four-wheeled trucks which run on two 3-ft.-gage tracks laid 26 ft. c. to c. The arrangement of these reloaders is unique. Each has an inclined belt conveyor parallel to the running track and leading up from the discharge of a trailing hopper truck, which receives coal from the motor cars dumping through the viaduct. This belt feeds a second conveyor carried at right angles in a hinged boom which runs out over the wharf and discharges through a telescopic chute at the end. The operator, in his elevated cab commanding a good view, moves the tower along the wharf and controls the position of the conveyor boom and delivery chute. Each reloader may be operated to give a capacity of from 60 to 600 tons per hr.

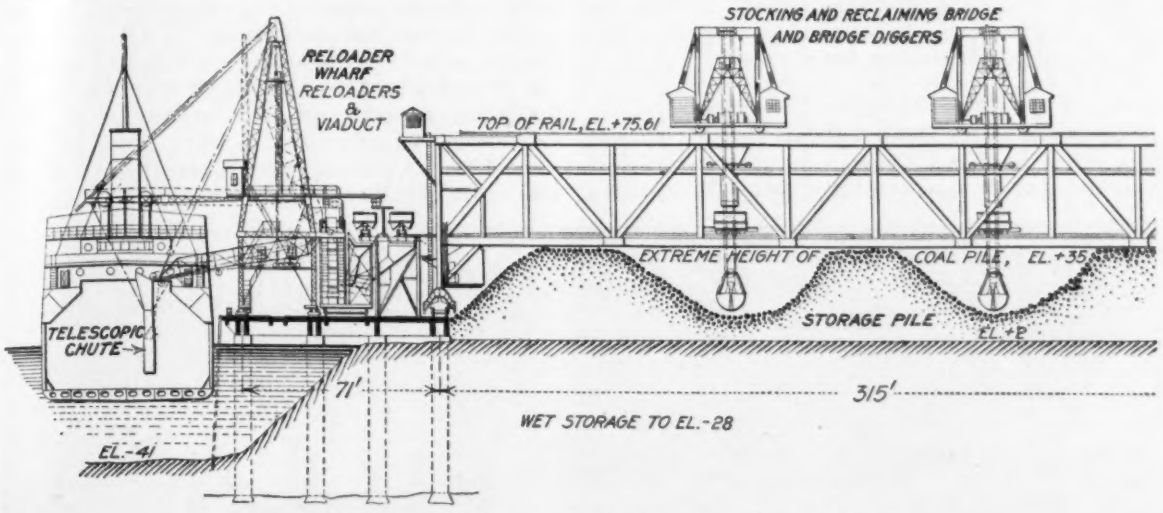


FIG. 2. PART ELEVATION OF THE CRISTOBAL COALING STATION

At the wharf bunker on the end of the pier an inclined conveyor carries coal from a receiving hopper under the viaduct and discharges it into a 1500-ton pocket, from which power-operated telescopic chutes let the coal into tugs and other small vessels. At the beginning of the shore extension of the pier is the transformer station of 2900 kv.-a. capacity. Three-phase 25-cycle current is received at 2300 volts, and is transformed to 440 volts for power and 110 volts for lighting. The administration tower, for the general control of the station, supports the conveyor leading to the wharf bunker.

The weight of coal handled is ascertained by semi-automatic scales at suitable points along the viaduct. A car must pass over a scale before reaching its point of discharge. The weight of coal delivered directly by the unloaders to standard-gage cars can be determined by track scales on the unloader-wharf track.

FIG. 3. DIFFERENTIAL DRUMS OF BRIDGE DIGGER

FIG. 4. MOTOR-DRIVEN COAL CAR

A complete system of communication and signals has been worked out. The total normal rated capacity of the station is 1000 tons per hr. unloading and 2000 tons per hr. reloading. To attain this, somewhat higher capacities had been specified for the individual units—1200 tons aggregate per hour for the unloaders and 2400 for the diggers and reloaders. The total wet-storage capacity is 100,000 tons; the dry-storage, 385,000 tons.

Balboa Coaling Station

The general arrangements at Balboa are quite different from those at Cristobal because of the different local conditions and the much smaller commercial importance of the Balboa station. Its equipment seems to be better adapted to the rapid reloading of coal than to rapid storage—in accordance with the military requirements. There are separate unloader and reloader wharves, but these are quay walls joining each other at an angle of 135 deg., the former being 850 ft. long and the latter 750 ft.

The reloader wharf substructure at Balboa is similar to the cylinder-supported deck construction at Cristobal. The unloader wharf is somewhat different in having a steel and concrete deck supported by rectangular concrete piers built in the open and dry.

There are two unloading towers similar to those at Cristobal and two reloading machines. There are no stocking and reclaiming bridges, but instead there are utilized the four berm cranes (rebuilt), used in the construction of the Pedro Miguel and Miraflores locks. There is a single-track viaduct running along the unloader wharf and up the center wall of the coal-storage platform, together with the two-track (loop) viaduct along the reloader wharf. The cars used at Balboa dump on one side only and in that way differ from the design for Cristobal. Coal is received either from the unloaders or from the cranes and is dumped into the hoppers of the wharf bunker or of the reloaders, or directly into the storage pile. The wet-storage basin is 310 ft. long and has a capacity of 50,000 tons of coal. The total dry and wet storage is 215,000 tons. The handling capacity is half that of the Cristobal station.

The general plans for the Cristobal and Balboa stations were made by the Division of Terminal Construction of the Panama Canal, under F. H. Cooke, Civil Engineer, U. S. N., as Designing Engineer.

The conveying systems and reloaders for both plants and the stocking and reclaiming bridges for the Cristobal station were designed and furnished by Augustus Smith, president of the Bergen Point Iron Works, Bayonne, N. J., the contract price being about $1,714,000. The unloading towers for both plants were furnished by the Hunt Construction Co., of New York, at a contract price of about $486,000. The heavy structural steel was subcontracted by the U. S. Steel Products Co. and the electrical equipment by the General Electric Co. The belt conveyors were furnished by the Robins Conveying Belt Co.

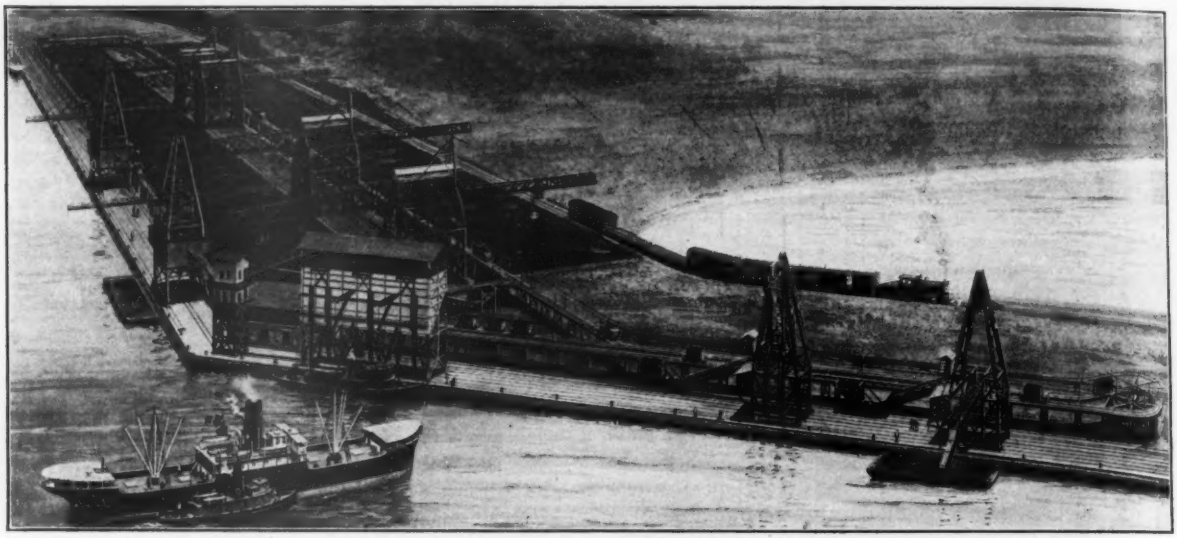


FIG. 5. THE BALBOA COALING STATION AT THE PACIFIC END OF THE PANAMA CANAL
From drawing by E. W. Spofford, of New York City

New Steel Plant in Australia—A new iron and steel plant belonging to the Broken Hill Proprietary Co., Ltd., has been erected at Port Waratah, Newcastle, New South Wales. It covers 264 acres and is situated near rich coal fields and limestone deposits and has excellent harbor facilities. The total cost to build and equip the plant was $7,000,000. The total yearly demand of Australia for steel rails is about 150,000 tons. The total imports of iron and steel for 1913 were 400,000 tons, with a local value of about $36,000,000. United States Commercial Attaché William C. Downs, Melbourne, stated recently that although this new enterprise will seriously affect the sale of American steel rails to Australia, which in recent years has amounted to about $5,000,000 per annum, it is gratifying that, after a careful study of the largest steel plants in Europe and the United States, American equipment was selected.

Prizes for Rubber-Factory Plans—It is announced at Rotterdam that the council of the International Association for Rubber Cultivation in the Netherlands East Indies offers an international competition for a plan for a complete rubber estate factory for making "crepe," and a plant for a complete rubber estate factory, for making "smoked sheets." Both plans are to be drawn in such a way that the capacity of the plant will amount in the beginning to 220,460 lb. of dry rubber per annum, which by three extensions can be increased to 551,156 lb. The plans should be accompanied by a detailed description of the plant and of the way in which the competitor considers the product should be treated, including the necessary machinery. The project may be detailed in English and should be sent in before Mar. 1, 1916, either to the office of the association, 13 Kneuterdyk, The Hague, Netherlands, or to the office of the Algemeene Vereeniging van Rubberplanters ter Oostkust van Sumatra, at Medan, Dutch East Indies. The first prize is for $603 and the second prize for $201.

Irrigation Weir, Measuring Rod and Discharge Card*

By Kenneth A. Heron†

An interesting type of weir and method of measuring canal flow are used in the Modesto Irrigation District, Stanislaus County, Calif. The greater number of the distributing structures in the canals and laterals are constructed of timber. At frequent intervals along the canals weirs of the type shown in Figs. 1 and 3 are placed. The primary object of these structures is to afford a vertical drop in grade, or a method of raising the head on a side gate to increase its discharge or to deliver water to high points. Movable flashboards are used to obtain the required head. The structures consist of two or more weirs, each about 3½ ft. in length, constructed on a downstream slope of between 35 and 45 deg. from the vertical.

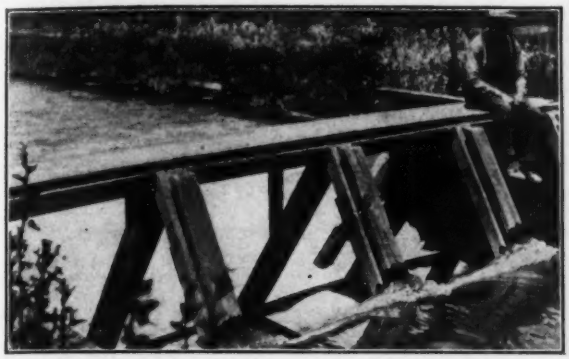


FIG. 1. WEIR IN MAIN IRRIGATION LATERAL
On downstream slope of about 40 deg. from vertical

A system that has been in use several years, of proportioning the canal flow by measurements made on these weirs, led the writer recently to conduct a series of experiments to determine its accuracy. The method of making measurements consists of holding vertically on the weir crest a ¾-in. smooth iron rod. A ring of water rises on the rod, which by measurements and computation has been found to approximate very closely the observed head plus the computed head of the approach velocity. From this head measured on the rod the discharge is computed by the Francis formula, as if there were no end contractions or slope to the weir.

The edge of the top board presents a sharp crest, and the center post and slide slots have the effect of forming fairly sharp end contractions.

Ditch tenders are furnished a card (Fig. 2) showing the discharge of a weir 1 in. in length under different heads. A measurement consists of merely observing the head with the ¾-in. rod and multiplying the tabulated discharge corresponding to the head by the length of the weir in inches, which gives the discharge in cubic feet per second for the stream.

OVERPOUR MEASUREMENT

Discharge in cubic feet per second for each inch of length of weir.
Multiply the length of the weir in inches by the multiplier opposite the head in inches and the result will be cubic feet per second.

Head Inches	Cu. Ft. Per Sec.	Head Inches	Cu. Ft. Per Sec.	Head Inches	Cu. Ft. Per Sec.	Head Inches	Cu. Ft. Per Sec.	Head Inches	Cu. Ft. Per Sec.
¼	.0024	5½	.0861	10½	.2271	15½	.4074	20½	.6196
1	.0067	6	.0981	11	.2436	16	.4273	21	.6424
1½	.0122	6½	.1106	11½	.2603	16½	.4474	21½	.6655
2	.0189	7	.1236	12	.2775	17	.4679	22	.6889
2½	.0264	7½	.1371	12½	.2950	17½	.4887	22½	.7125
3	.0374	8	.1511	13	.3129	18	.5098	23	.7363
3½	.0437	8½	.1654	13½	.3311	18½	.5312	23½	.7605
4	.0534	9	.1803	14	.3497	19	.5528	24	.7849
4½	.0637	9½	1955	14½	.3687	19½	.5748	24½	.8096
5	.0746	10	.2111	15	3878	20	.5971	25	.8344

FIG. 2. DITCH-TENDER'S CARD FOR WEIR COMPUTATIONS

The original was 5¼ x 3¼ in.

The accuracy of the method has been demonstrated by carefully made current-meter measurements. In the following table weir measurements, made in the manner described, check very closely with the meter measurements:

Date	Lateral	Weir Measurements, Sec.-Ft.	Meter Measurements, Sec.-Ft.
5-11	1	51.31	51.41
5-22	3	78.00	77.36
5-22	4	120.00	121.51
6-11	3	241.00	245.08

Naturally, ideal conditions are not found at all of the structures. Such things as leakage and obstructions occur at times, but for all practical purposes, where measurements are necessarily made by ditch tenders of little special training, the results obtained are as close as could be desired. The method has a distinct advantage over measurements made by means of vertical weirs in that it is simple and does not require a special structure and, as shown above it is accurate enough for most purposes.

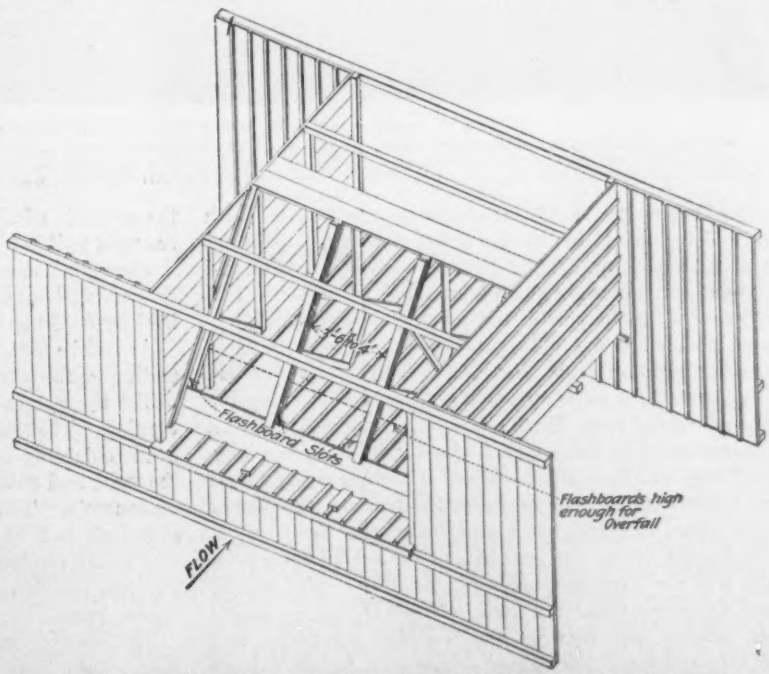


FIG. 3. SKETCH OF STANDARD STOP-GATE OR WEIR, MODESTO IRRIGATION DISTRICT, CALIFORNIA

*Abstracted from a report by the writer on "The Use of Water in the Modesto Irrigation District, Stanislaus County, Calif."

†Modesto, Calif.

Ninth Street Pier in Lake Erie at Cleveland, Ohio

SYNOPSIS—First large lake pier at Cleveland, used by the Detroit and Buffalo boats. Built by the steamship companies under the direction of the city and to revert to the city at expiration of lease. Construction is earth fill between gravity concrete walls. Special attention paid to architecture and arrangement of headhouses. Connected to trunk line railways.

The new pier in Lake Erie at the foot of Ninth St., Cleveland, Ohio, which was opened for service late in June of this year, marks a radical development in the harbor of that city. Hitherto practically all of the lake traffic steamers have docked along the tortuous channel of the Cuyahoga River, although an extended breakwater has for some years protected the lakefront of the city proper. About five years ago the city authorities initiated a project to enlarge an existing old pier at the foot of Ninth St. and to lease it to the steamship companies operating large passenger and freight steamers between Detroit and Cleveland and Buffalo and Cleveland.

Some difficulties with the arrangement immediately came up on account of arguments by the owners as to riparian rights at this location. In 1873 the city had appropriated for park purposes a strip of land along the lake extending from East Third to East Ninth St. All the area north of the railroad which runs along the lakefront here was then water. When it was planned to lease the waterfront for pier purposes the heirs of the owners from whom the land was appropriated instituted suit to restrain the city on the ground that the earlier appropriation was for park purposes and the front could not be used for commercial purposes. However, an agreement was entered into between the shipping companies and the city and work was started on the pier, but an injunction immediately served brought about legal controversies which were not settled until May, 1914. At that time work on the new pier began again in earnest and was completed in about a year's time.

The old pier which was replaced was 100 ft. wide and extended out from the bulkhead line 720 ft. It consisted of an earth fill between side and end bulkhead walls, which were made up of tight rows of round piles tied together with rods and waling pieces and filled with riprap, the earth fill backing against a row of sheet piles just inside of the bulkhead. Sections through these old bulkhead walls are given in Fig. 3. The new pier is also 720 ft. long and is 300 ft. wide; it is made up of a continuous line of concrete wall of gravity section, which along the east side and a part of the lake side is founded on the old pile bulkhead, and along the rest of the lakefront and on the west side is founded on new timber piles driven for the purpose. The old bulkhead piles were sawed off to 1 ft. below low-water level and embedded in the concrete of the wall 1 ft., so that the bottom of the concrete wall is 2 ft. below water level. The concrete wall is strengthened against the pressure of the interior fill by 2-in. anchor rods extending back into the earth fill and held by deadmen of two or three piles.

FIG. 1. NEW NINTH ST. PIER IN LAKE ERIE AT CLEVELAND

At the left, or west, at the dock, is one of the boats of the Detroit & Cleveland Navigation Co.; next is the pier of this company, then the pier of the Cleveland & Buffalo Transit Co. with the new "Seeandbee," the largest fresh-water passenger boat, at dock. The plaza in front lies between the lake and the railway lines which have sidings onto the piers

As will be noted from the sections in Fig. 2, the gravity section of the wall on the new piles has been designed to utilize the weight of the fill as a protection against overturning. That part of the wall built over the old bulkhead foots only on the outer piles of the bulkhead, and the inner and outer pile rows are tied together by a paving of concrete. The westerly bulkhead of the old pier is sawed off to 3 ft. 10 in. below the top of the new pier. The interior columns which support the structure on the pier are founded on prismatic concrete piers footing on timber piles.

The concrete wall has a remarkably good line and surface. Considerable care was taken to get a good finish on the outside and also in backfilling the wall.

In superficial plan the pier is in duplicate design on either side of a center longitudinal line, one-half being leased to the Cleveland & Buffalo Transit Co. and the other to the Detroit & Cleveland Navigation Co. Each half contains a freight shed with a headhouse, which is used as an office, a roadway running down to the end of the pier and up into the freight shed, and railroad tracks running out alongside of the freight shed. The floor of the freight sheds on the Cleveland and Buffalo side is of 3-in. oak on 5x5-in. sleepers laid in cinders. This is the side of the old pier; but the manager of that line was afraid of settlement which might damage a concrete floor and so built a timber floor. In the other freight shed the floor, though on a new fill, is of concrete.

The sheds are of fireproof construction, with steel frame and roof trusses, reinforced-concrete tile roof slabs and brick curtain walls. The headhouses, views of which are shown in Fig. 4, are quite pleasing in design. They are of brick and steel construction, with brick walls. The brick is a wire-cut mat surface; the lower ten courses are dark red and the rest of a grayish tone. In front of the headhouses is a strip of paving 75 ft. wide and 700 ft. long, on which runs one of the lines of the Cleveland street-railway system. The street-car fare to and from the public square is one cent. If the passenger does not have a penny, change is not made in less than nickels, but the regular Cleveland three-cent ticket may be used.

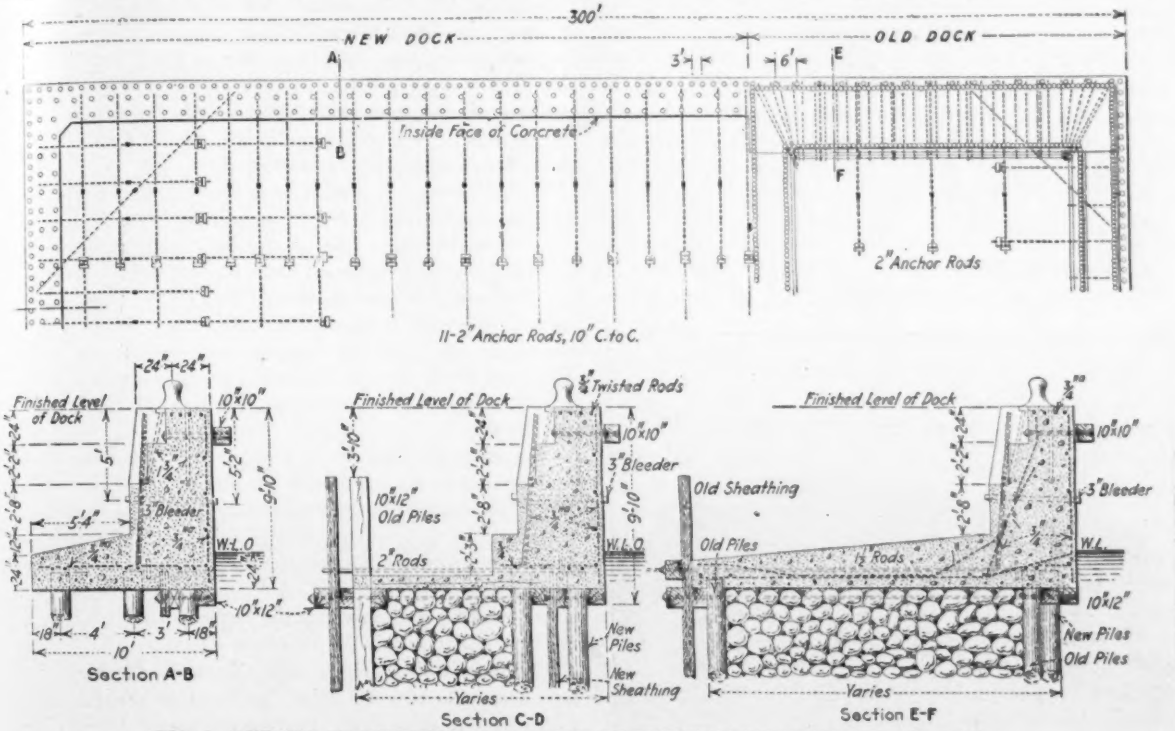


FIG. 2. DETAILS OF THE PIER STRUCTURE OF CLEVELAND'S NEW NINTH ST. PIER

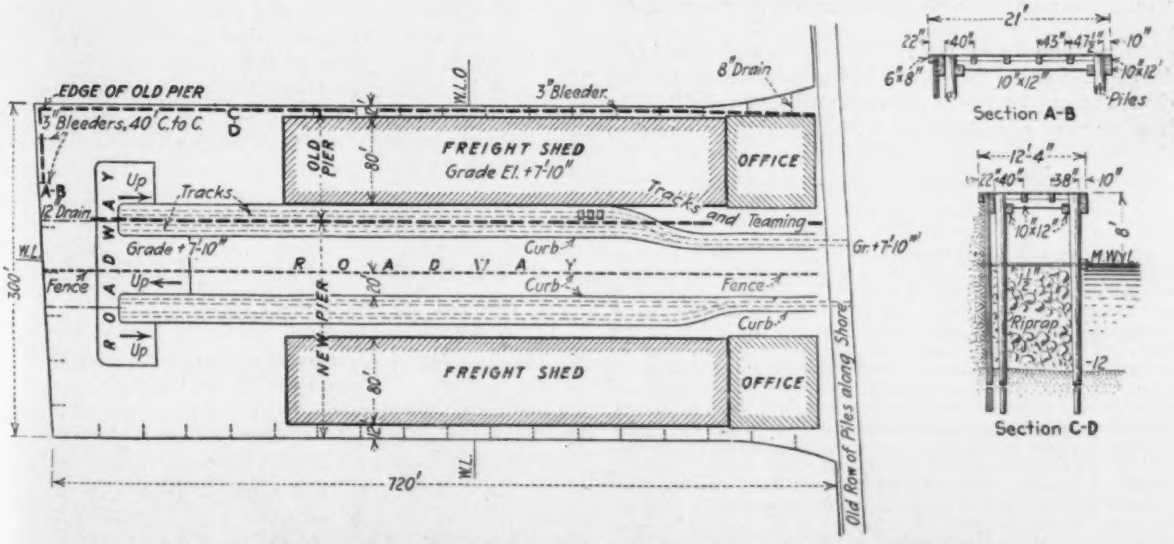


FIG. 3. GENERAL PLAN SHOWING OLD AND NEW NINTH ST. PIERS AT CLEVELAND

The design and construction of the pier had to be approved by the city of Cleveland, and E. B. Thomas, Assistant City Engineer, in charge of River and Harbor Department, was the city's representative. The lease between the Cleveland & Buffalo Transit Co. and the Detroit & Cleveland Navigation Co. on the one hand and the city of Cleveland on the other hand stipulates that the shipping companies shall have exclusive right to the pier from 1913 to 1953 on payment of an annual sum of $1000 and an assumption of the total cost of the whole construction, which amounted to about $450,000. At the end of the lease period the property reverts to the city. At any time before 1953 the city can obtain the property by a two years' notification and payment of the actual cost of the work; but the city cannot in such a contingency lease the pier to other parties engaged in a similar business. One curious feature of the lease is the stipulation that the lessees shall at no time permit the improvements to deteriorate or depreciate below "70% of their reconstruction value," said maintenance to be at the sole cost and expense of the lessees. It is, however, nowhere stated what is meant by the term "reconstruction value." The shipping companies employed W. S. Lougee, of Cleveland, Ohio, for the design of the pier and the contract for the work was held by George R. Cooke, of Detroit, Mich.

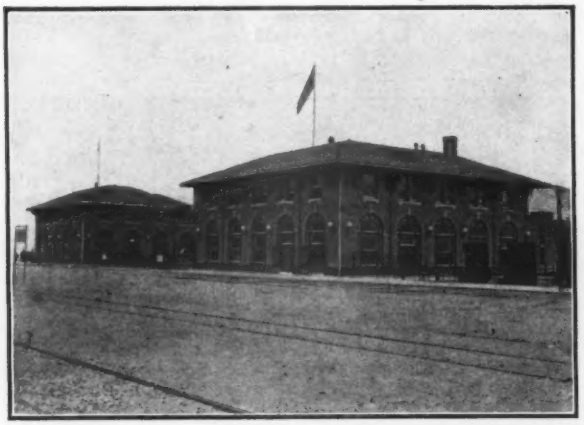


FIG. 4. HEADHOUSES OF NINTH ST. PIER, CLEVELAND

Stresses in Railway Track under passing trains have been investigated by J. T. Williams, professor of railway engineering, University of Kansas, and are described in a paper in the "Railway-Age Gazette." The apparatus used consisted of a recording instrument which measured the deflection of the track and Berry strain gages for measuring the stresses in the rails. Tests were made by senior students in the Department of Railway Engineering under the direction of Professor Williams, and measurements were made both on a main-line tangent where trains passed at full speed, on a 30-deg. curve, and on a tangent yard track near a station. Some of the important results obtained by the experiments are as follows: Stresses in the end of the rail were 25 per cent. greater than at the middle; the end of a rail at a joint is subject to intense vibration resembling that of a tuning fork, so that it was impossible to attach strain gages to the rail. Professor Williams thinks that these vibrations account to some extent for the crushing of angle bars. Freight cars cause fully as high stresses as passenger coaches, notwithstanding the greater wheel loads of the latter. The reason is thought to be the crude construction and condition of freight-car rolling stock. Flat spots on wheels increased the stresses 50 to 100 per cent. Variations in the speed of a train had no noticeable effect on the stresses. Stresses measured in the head of the rail averaged from 6000 to 10,000 lb. per sq.in. The maximum deflection of the track on stone ballast was about 0.3 in.

Reconstruction of Mississippi River Bridge at Keokuk

An interesting case of the reconstruction of large bridges to meet modern requirements of loading and traffic is the renewal of the superstructure of the Mississippi River bridge which connects Keokuk, Iowa, with Hamilton, Ill. The present bridge is of special interest from the fact that it was built as long ago as 1869. The original swing span was renewed in 1871, and in 1881 one of the fixed spans was knocked down by a steamer and rebuilt the same year. The steelwork is in good condition after 45 years' service, but the structure is too light for present traffic conditions.

The old bridge is 2194 ft. long between abutments, with ten fixed spans and a 380-ft. swing span, this last having been a notably large span at the time of its construction. It is a single-deck structure with through-truss spans, and its 20-ft. roadway serves for railway traffic (Toledo, Peoria & Western R.R. and Wabash R.R.), for the local street-car line and for highway and pedestrian traffic. Highway traffic is excluded when trains approach. It is a toll bridge and is owned by the Keokuk & Hamilton Bridge Co.

The masonry piers are at a slight skew with the bridge and are built on solid rock at very little depth. They are in good condition and require only small repairs; but they will have new tops and bridge seats of reinforced concrete to provide for the new structure. The rail level and highway deck will be 27.5 ft. and 56.7 ft. respectively above Keokuk datum, while the highest flood level in the river at this point is 14 ft. above datum.

The new bridge will be a double-deck structure, thus separating the two classes of traffic while maintaining a width which can be carried by the old piers. The railway track (for steam trains and electric cars) will be on the lower deck, and the highway and a single sidewalk will be on the upper deck. The swing span is at the Keokuk end and is 380 ft. long. Next to this are two fixed spans of 254 ft. 6 in., with curved top chords; and beyond these are eight parallel-chord spans of from 148 to 162 ft. The railway approaches consist of earth fill at the east end and 200 ft. of I-beam spans at the west end. The highway approach at this end (1.8 per cent. grade) has about 600 ft. of viaduct and a short fill to the street level. The highway approach at the east end (5 and 6 per cent. grade) has 12 girder spans of 30 ft. (on bents) and 300 ft. of retaining wall and fill.

The new bridge is designed for Cooper's E-50 loading for trusses and track, no highway load being considered for the trusses. The omission of the highway load for proportioning the truss members is based on the fact that while the unit stresses are approximately the same as those generally used for railway structures, the steel called for by the specifications is of a higher grade and has an elastic limit at least 20 per cent. higher than so-called commercial steel. Therefore the steel can be allowed 20 per cent. higher strain, and this excess in strength will take care of a highway load of 1500 lb. per ft., which is more than sufficient for any possible local conditions of traffic.

The upper floor is designed for a live-load of 100 lb. per sq.ft. and a 17½-ton road roller. The dead-load is about 3400 lb. per lin.ft. of bridge for the 160-ft. spans, 4200

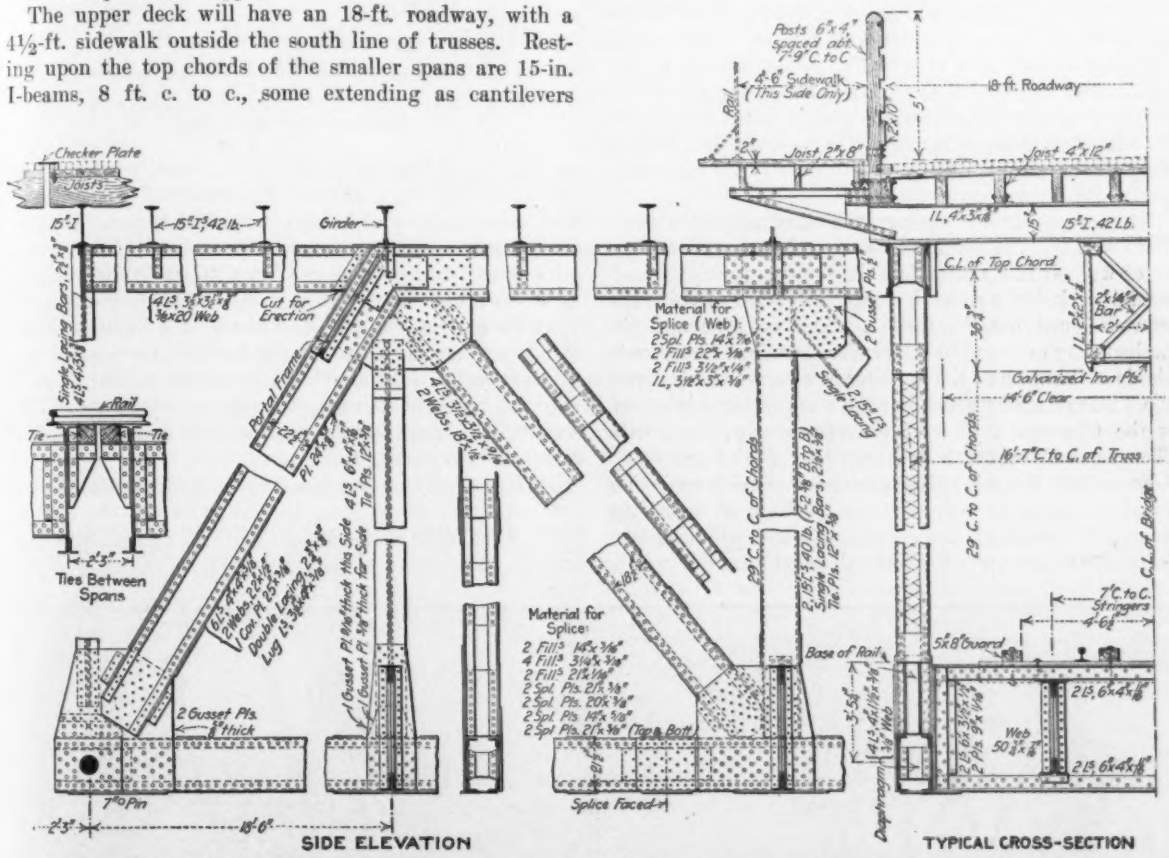
ft. for the 254-ft. spans and 4000 lb. for the draw span. For wind load, the top laterals (unloaded) and bottom laterals (loaded) are calculated for 500 lb. and 450 lb. respectively. The truss depth is from 29 to 32 ft. The trusses are spaced 16 ft. 7 in. c. to c. in the shorter fixed spans and 20 ft. 6 in. c. to c. in the two longer spans and the draw span. Openhearth steel is to be used, from 62,000 to 70,000 lb. ultimate strength for medium steel and from 52,000 to 60,000 lb. for rivet steel, with elastic limit not less than 37,000 and 30,000 lb. respectively.

The shorter fixed spans have riveted trusses, with pin bearings in the end shoes. The longer ones have riveted and pin-connected trusses. The swing span is riveted, except for the eye-bar ties from the tower to the hips of the trusses. The drum is 29 ft. diameter and 63 in. deep, with eight radial struts, and the trusses are placed upon it at four points of support.

The upper deck will have an 18-ft. roadway, with a 4½-ft. sidewalk outside the south line of trusses. Resting upon the top chords of the smaller spans are 15-in. I-beams, 8 ft. c. to c., some extending as cantilevers soted wood blocks. The sidewalk will have a single course of 2-in. untreated plank laid across the joists.

A wood fence will be placed on the outer side of the roadway, and the old iron railing will be replaced along both sides of the sidewalk. Electric wires will be carried across the bridge on cantilever brackets on the north side of the upper deck; but on approaching the navigation channel they are to be raised to about 50 ft. above the rail level and then swung inward to cross the drawspan on the center line of the bridge.

The lower deck will have 50-in. plate-girder floor-beams framed between the truss posts. Between these will run two lines of track stringers 7 ft. c. to c., set so low that the tops of the ties are 1½ in. above the floor-beams. The track will be laid with 8x8-in. ties, 12 ft. long, spaced about 12 in. c. to c. They are boxed out over the string-



TYPICAL DESIGN OF NEW DOUBLE-DECK SUPERSTRUCTURE FOR THE MISSISSIPPI RIVER BRIDGE AT KEOKUK, IOWA

on the south side and others having cantilever brackets attached to them. At the portals, plate girders take the place of the I-beams. In the swing span and the longer fixed spans, where the trusses rise above the road level, the floor-beams are framed between the truss posts, and the sidewalk is carried by cantilever latticed brackets outside the posts.

The floor-beams will carry ten wood joists 4x12 in. for the roadway and three 2x8-in. joists for the sidewalk. The roadway is to have a deck of 3-in. tongued-and-grooved planks laid upon the joists and covered with a three-ply layer of roofing felt mopped with hot pitch, and upon this will be relaid the old paving of 3-in. creo-

ers, and every third tie is to be fastened to them by hook bolts. At the ends of the spans the ties are placed close together, being carried on brackets on the end floor-beams, as shown. There will be two guard timbers, 5x8 in. The inner one (8 in. from the rail) will not be boxed, but bolted to every tie; the outer one will be boxed and bolted to every third tie.

The single track will be used by both steam trains and electric cars, interlocked connections being provided at each end. In order to protect the steel of the upper deck from the blast and gases of the engines an inverted trough of galvanized iron plate will be suspended by hangers from the I-beams of this deck.

The new bridge was designed by Ralph Modjeski, consulting engineer, of Chicago, and the work will be done under his supervision. The contract for the erection has been awarded to the Strobel Steel Construction Co., of Chicago. Work on the fixed spans will be commenced at once, and it is expected they will be completed by the opening of navigation in 1916. The drawspan will be left until next winter, when the river is closed to navigation. The old bridge will be kept in service, both as to railway and highway traffic, during the erection of the new structure.

Plastic Concrete Mattress for River Revetment

During the past year a number of experiments have been carried on in the Passaic River near Newark, N. J., with a machine designed to lay a plastic concrete mat as a protection against caving and erosion on the sloping underwater bank of a river. The results proved so successful that an effort is now being made by the inventor to have the Mississippi River Commission adopt the scheme for the subsurface protection of the banks of that river in place of the ordinary willow mattresses which have been used there for so many years.

The accompanying photographs illustrate the Passaic River work. The submitted design for the Mississippi River work is in its essentials the same as for the experimental work, but a somewhat more elaborate machine has been designed for the former. The machine and the method were invented by Alexander Crawford Chenoweth, who is well known as the inventor of a reinforced-concrete pile. The company which has the work in hand is known as the Chenoweth Concrete Revetment Co., Inc., with offices in the Woolworth Building, New York City.

Essentially the method of protection consists in laying a mat of reinforced concrete on a platform on a floating barge. By means of endless chains running underneath the mat, it is conveyed while still plastic to the underwater slope of the bank and paid out as made until the end of the mat has reached deep water, where erosion is not likely. The concrete is mixed sufficiently dry to prevent dissolving when submerged, and is paid over the side of the barge before it has set hard. Consequently the mat takes the conformation of the ground on which it is laid.

The machine used for making the experimental slabs was in accordance with the details shown in Fig. 3 and the views in Figs. 1, 2 and 4. An ordinary barge was equipped with a derrick and at its outer end an apron hinged to move in a vertical plane. The forming-board on which the mat was laid extended back on the barge and the endless chains were carried under this forming-board over the apron and back again. On the forming-board was first placed a layer of heavy commercial burlap. On this was laid the reinforcement, which consisted of triangular wire mesh crimped so as to form a Z section every 12 in. on a 4-in. fold. The crimping of the mesh serves to prevent the concrete from sliding down steep inclines before it has set, and also insures the location of some of the reinforcement in the middle of the section no matter what angle of bend the slab may take during placement. The burlap holds the concrete together and insures the continuity of the mattress.

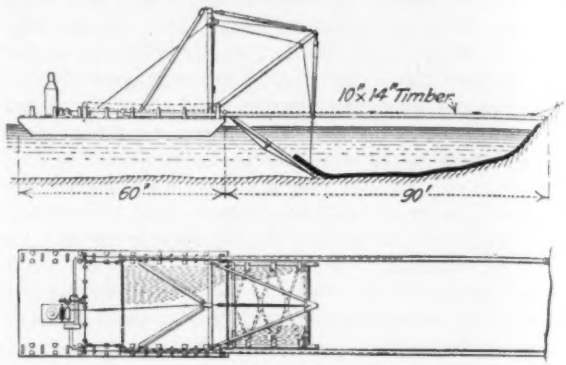
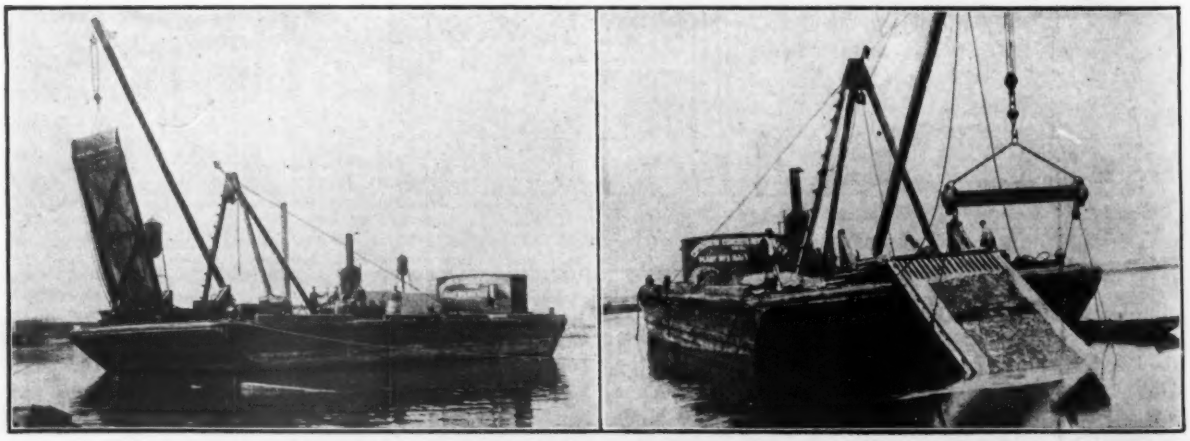


FIG. 3. PLAN AND ELEVATION OF PASSAIC RIVER REVETMENT MACHINE

In operation this machine deposited a reinforced-concrete covering 60 ft. long and 25 ft. wide. It worked offshore, being held in position by the longitudinal spuds shown. The concrete mat retained its integrity while being placed and apparently set hard under the water without any break.



FIGS. 1 AND 2. PASSAIC RIVER CONCRETE REVETMENT SCOW WITH APRON UP AND DOWN

The accompanying views show some of the work on the Passaic. Fig. 4 is a view from the barge looking offshore across the apron, with part of a concrete mat being pushed out along the apron. Fig. 1 is a general view of the

barge with the apron elevated, and Fig. 2 is a view of the barge with the apron depressed.

For the Mississippi River work a somewhat more complicated machine has been designed. The features of the method presented to the commission contemplate a reinforced-concrete covering 4 in. thick, made in widths of 30 ft. or more, and of sufficient length to permit depositing it in a continuous layer on the slope under water to a depth of 70 ft. from the water line. The machine (Fig. 4) consists of a barge with a recess in the midsection forward containing a hinged apron 80 ft. long and 30 ft. wide. This apron is built up of air-tight tubes sufficiently buoyant to float the apron when not loaded.

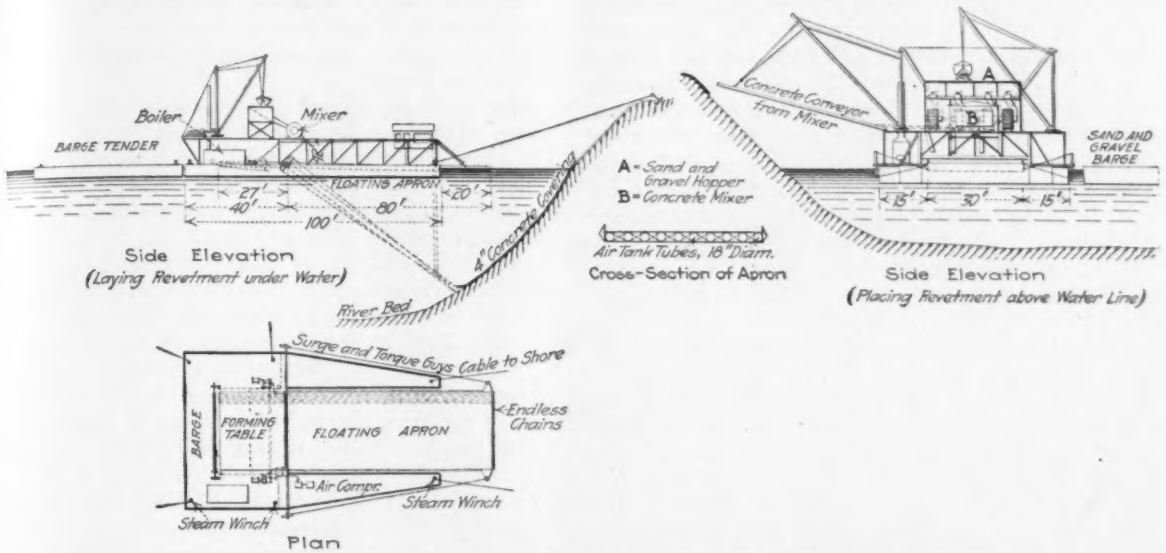


FIG. 4. DETAILS OF PROPOSED REVETMENT MACHINE FOR MISSISSIPPI RIVER

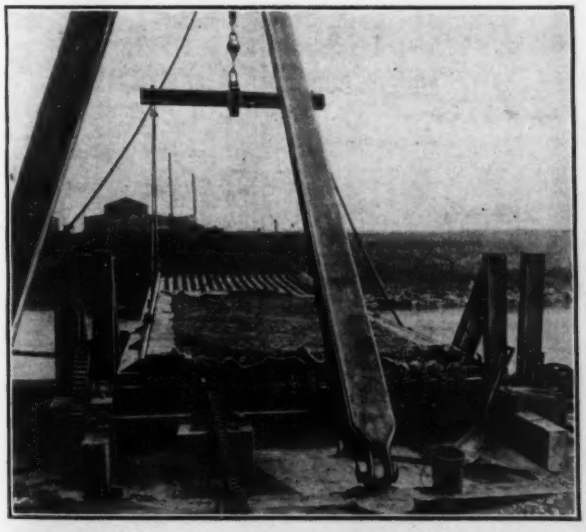


FIG. 5. LOOKING OVER THE APRON OF THE PASSAIC RIVER MACHINE

Air can be forced into the cylinders or water admitted to balance the apron during the operation. This balanced apron is necessary because a derrick to handle the heavy slabs intended for the Mississippi work could not be economically designed.

Back of the apron hinge is a forming table 30 ft. wide with sideboards 4 in. high (the thickness of the covering to be made). These sideboards also extend onto the apron. Over the top of the fixed table are endless link-chains, every third link containing a projection which engages the plastic slab cast on the forming board and carries it along overboard in a continuous sheet, the barge backing away from the shore so as to permit the paying-out operation. This backing away will be started by pulling in on an offshore anchor; but it is thought that as soon as any considerable length of mat has been cast the weight of the concrete will force the boat out into the stream, and then the backing can be controlled by shore lines.

It will be noted that the barge is equipped with a concrete mixing plant and also with derricks, so that it can be used for above-water revetment work.

It is the intention to cast the mats in 30-ft. widths and to overlap them about 2 ft. The plastic concrete should bond to the slab below at the overlap and form a continuous covering along the bank. Observations on the Passaic slabs for over a year lead the inventor to believe that a mat so formed will remain intact under the wash and wear of the river and will form a more effective and durable covering than the willow mattress.

Grade Elimination on Lackawanna at Buffalo—The progress being made on the extensive grade-elimination work on the Buffalo division of the Delaware, Lackawanna & Western R.R. is indicated by the recent formal opening of the new overhead crossing at the Nickel Plate junction, south of the intersection of Abbott Road and the Buffalo River, Buffalo, N. Y. By this improvement Lackawanna trains are no longer compelled to cross the Nickel Plate, Pennsylvania or Buffalo Creek railway tracks. This work was discussed with particular reference to the use of heavy plate girders in "Engineering News" of May 27. One of the most important items in this project was the construction of the foundations of a bascule bridge over the Buffalo River, which was described in detail in our issue of July 8. The grade-elimination work was done under traffic, and so as not to interfere with the movement of about 700 cars daily interchanged. When the bridge was built over the tracks, the intervals between trains on the cross lines averaged six minutes. The fill amounted to about 500,000 cu.yd. For the past two years about 200 men have been working on this project. The new bascule bridge was required on account of the straightening of the Buffalo River, under way by the city.

Should Ferry Service Be Free?

By H. M. Chittenden*

Certain ferries across Lake Washington and Elliott Bay in Seattle are built and maintained by the Port of Seattle, a municipality coterminous with King County, in which the City of Seattle is located. The county itself maintains a ferry across Lake Washington, and there is also a private ferry on the lake. All these charge for service, the rates being fairly uniform and quite low. No complaint is made that the charges are onerous or obstructive of use, but extreme advocates of public ownership argue that the ferries should be free, as an essential part of the public highway system, just as bridges, which perform exactly the same office of carrying the highway over bodies of water, are free. On the face of it the argument looks reasonable, and the purpose of this article is to inquire whether in fact it is so.

As an economic proposition, freedom of use of the public highway stands on a perfectly logical basis. In any case, whether free or toll, the user has ultimately to pay the cost of construction and maintenance. With the toll road he has to pay the additional cost of collecting the tolls and of profit to the holder of the privilege. Except for these extra charges, the account should balance itself so far as mere outlay is concerned. The private builder of the toll road may do his work more economically and thus somewhat reduce the burden; but at the same time his plans are sure to be less comprehensive, and in these days the work would surely be of a lower standard. But the chief economic objection to toll roads is that the toll restricts use. To avoid the payment of toll the user will resort to inferior roads when weather or other conditions make it possible, and this involves a waste of energy and a consequent burden upon traffic which must appear in prices or in a drag upon business activity. Absolute freedom of use means a maximum of use and increases to a maximum the utility of the work. Moreover, toll roads, when they were general, were mainly restricted to trunk lines, and the development of other roads suffered. Toll roads were undoubtedly a blessing at a time when the country was practically without other roads worthy of the name; but their day of usefulness has passed, and the world fully recognizes the economic advantage of perfect freedom of use.

Accepting, then, the principle of the free public highway as thoroughly sound, and admitting that culverts, bridges, etc., are an organic part of the road itself, subject to no special charge, why not treat the ferry exactly as we do the bridge? Both serve the same purpose of carrying the traffic of the public highways over otherwise impassable barriers—generally water courses. Why should we charge for one and not for the other?

The answer is this: The freedom of the public highway is a freedom of use. If anyone wishes to walk or drive along it or transport goods, the public makes no charge. But the public does not undertake to transport him or his goods, except in special cases, one of which is the ferry. It is impracticable for the user to operate the ferry. The owner or lessee must necessarily do that. And so the public, as owner, builds the landings and the boat and operates the property. It goes into a sort of compulsory transportation business to that extent. It not only provides the highway, but it carries the passenger and goods. The user is thus saved the expenditure of physical energy of himself and animals, wear and tear of equipment, expenditure of fuel oil, etc., in motor conveyance, over the route of the ferry. For this service, which is entirely special and in addition to that afforded by a bridge, it is right that the user should pay. He is simply paying for a service which, in the case of a bridge, he performs himself.

The strictly logical and consistent basis of public-ferry charge differs somewhat from that on private ferries. The latter must charge enough to cover service, upkeep, interest on outlay and a reasonable dividend. The former should really charge only for that service which is in addition to the ordinary highway; that is, for the transportation which it furnishes. It should not include the cost of maintenance of structures, or any interest on cost of construction, any more than it would make such charges for a bridge. These should be covered in the tax budget with other highway costs. The tariff should logically embrace wages of crew, expenditures for power, oil, and other directly operative outlays. This would of course make competition by private ferries on the same route impossible.

Another reason why there should be a ferry charge is found in the method of raising money for public highways. This is done by general taxation. As highway use is general and property values generally highest where roads are used most and the cost of maintenance greatest, the system is theoretically and practically equitable—as much so as any system would be which it is possible to devise. But ferries are special and exceptional facilities, affecting, as a rule, only limited portions of a community. They are in no sense so universal as bridges and the roadway itself. To make them free would thus be taxing a whole community for a special benefit to a limited portion.

*Brigadier-General, U. S. A., retired, 2010 Broadway N., Seattle, Wash.

Constructing an Outfall Sewer at Canton, Ohio

Lively work is being done on an outfall sewer at Canton, Ohio. The John F. Casey Co. contracted to build the sewer in 300 days. At the end of the first month a mile had been laid. Subsequently the pace was increased. The rapid progress is due to good equipment and management.

The sewer is being constructed from the corporate limits of the city to the new sewage-disposal plant. Of a total length of 31,000 ft. of sewer, 26,000 is of segmental hollow-tile block supplied by the American Sewer Pipe Co., of Akron, Ohio, and the remainder (three siphons) is reinforced-concrete pipe made on the job by the Lock Joint Pipe Co., of New York. The segmental-block section is 39 in. diameter and one of the siphons is a single line of 39-in. pipe, 1150 ft. long. The other two siphons are double lines of 30-in. pipe, with a combined (siphon) length of 3875 ft.

Segmental block were adopted because the sewage is acid in character, because of the smoothness of the interior surface and because the bids for the block were $20,000 lower than the lowest offer for the other materials bid on—brick and concrete. It may be added that the interior of the concrete pipe used for the siphons was smoothed by men wearing rubber gloves.

The sewer has a grade of 0.1 per cent., a friction coefficient of about 0.011, an estimated velocity of 2.87 ft. per sec., and a calculated capacity of 18,000,000 gal. a day. Figs. 1 to 4 are views showing some of the trenching and pipe-laying work. The depth of trench ranges from 6 to 22 ft. and averages about 12 ft. The material encountered is about 80 per cent. gravel and sand and 20 per cent. rock consisting of limestone and shale. The limestone is being drilled with Ingersoll-Rand Jackhamer drills, with air supplied by Westinghouse cross-compound pumps.

That portion of the sewer which is in gravel and sand is being excavated by an Austin trench machine and backfilled with a Marion steam shovel. All material is being hauled by teams from the nearest railway siding. An industrial railway has been used at some points, and a cableway was used on a side-hill.

The concrete pipe is being cast on the ground and lowered into place in the usual manner. The segmental blocks are being laid upon circular collapsible forms.

Ottamar Stange, of the John F. Casey Co., is in direct charge of the work, J. B. Bowen is field superintendent for the contractor, and G. H. Wynn is resident engineer for the city. W. E. Sarver is city engineer and Z. W. Kent is director of public service.

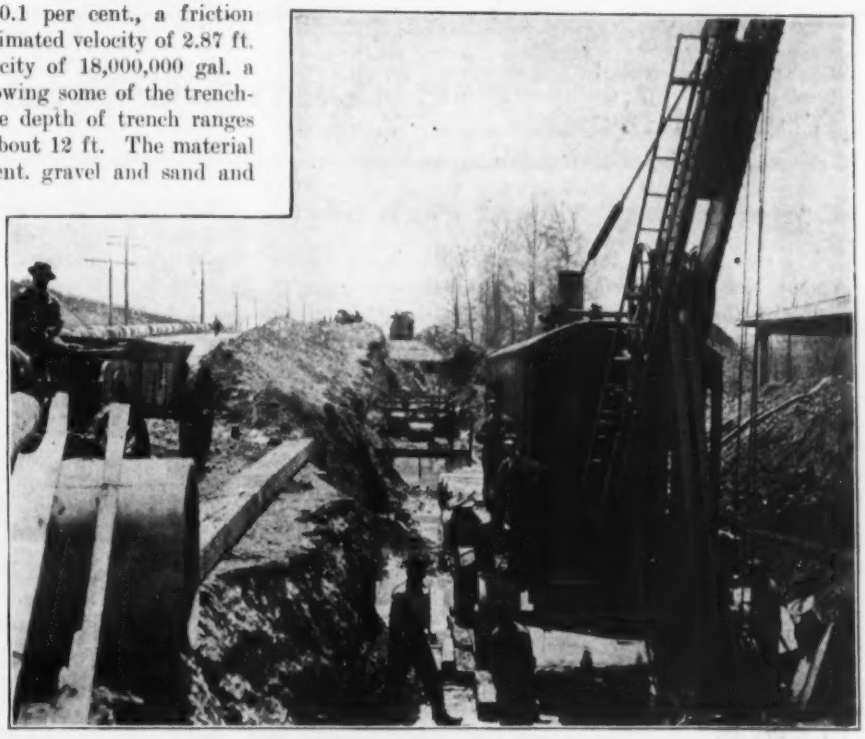
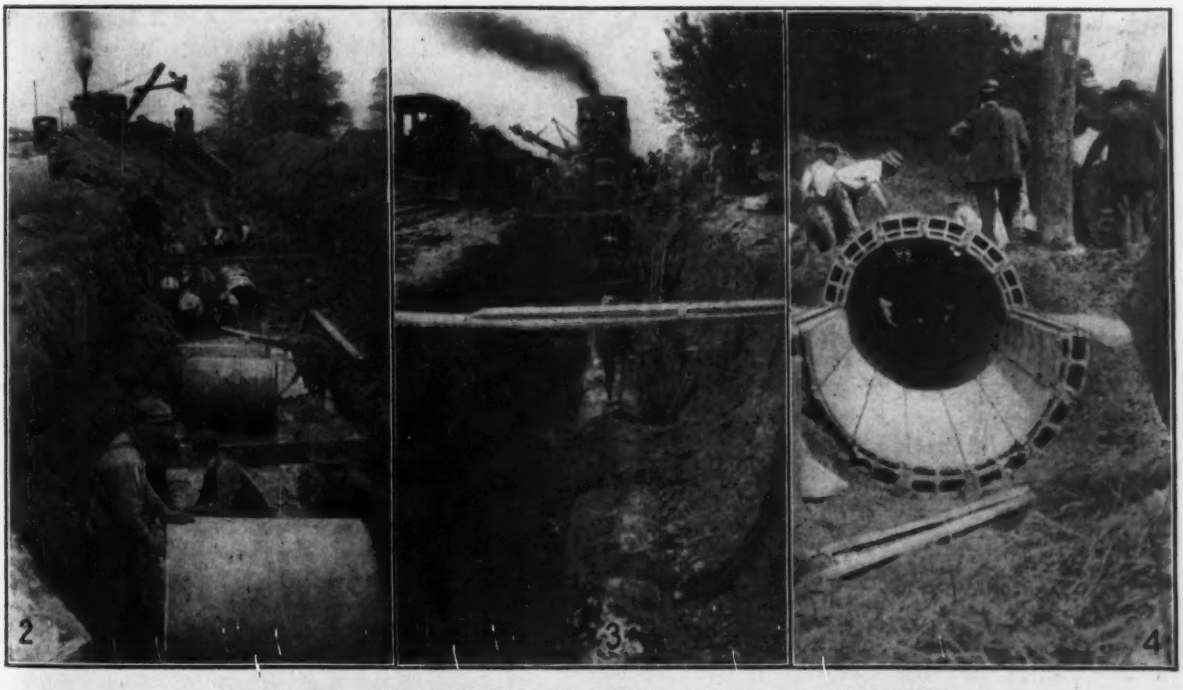


FIG. 1. TRENCHING FOR TWO 30-IN. CONCRETE SIPHONS, CANTON OUTFALL SEWER
Steam shovel in foreground, trench machine in background

The Proper Gage for Australian Railways is to be considered by an international board of engineers, according to a decision reached at a conference of the premiers of the Australian colonies. The board will be asked to investigate and report upon the need of a uniform gage, the best gage for adoption in view of present and future developments, the best method of changing existing lines to conform to the standard if adopted, and the probable cost of such gage changing.



FIGS. 2 TO 4. CONSTRUCTING THE OUTFALL SEWER AT CANTON, OHIO

Fig. 2—Steam shovel backfilling trench for double 30-in. siphon; trench machine in distance. Fig. 3—Trench machine and dinkey engine on 39-in. siphon. Fig. 4—Close view of 39-in. segmental block sewer

Field and Office

Concrete and Wood Park Seats

The seats in a new band park at Redlands, Calif., are made up benches formed by planks slid through concrete standards shaped so as to give the proper contour to the seat. The view in Fig. 1 shows the standards as cast and Fig. 2 gives an idea of how the seats look when placed on the earth slope rising from the band stand. The construction is novel and recommends itself not only on account of the ease of removal or transfer but also because of its pleasing appearance.

FIG. 1. CONCRETE FRAMES

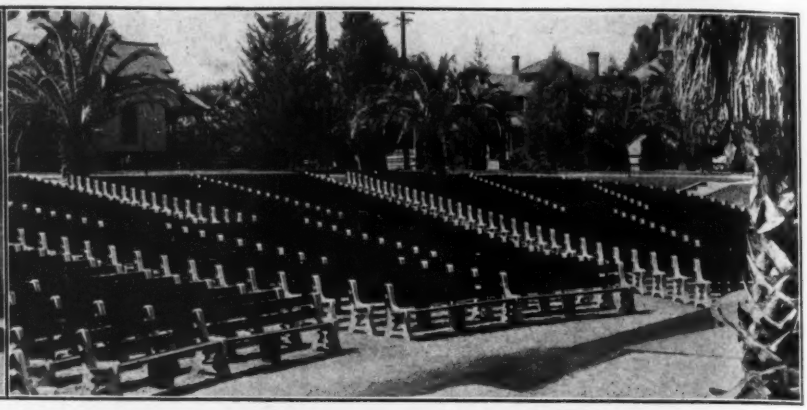
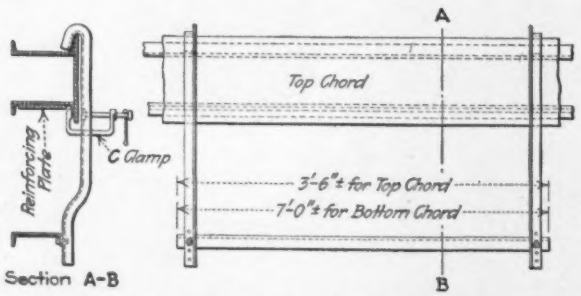


FIG. 2. SEATS MADE BY SLIPPING PLANKS THROUGH FRAMES

Successful Winter Drilling on the Barge Canal

By W. R. Brown*

Reinforcing three trusses on the upstream side of the New York State barge canal at Dam 5 necessitated the drilling of 8539 holes. More than 90% of them were $1\frac{13}{16}$ in. in diameter. The remaining holes were $1\frac{15}{16}$ in. It was found practical to drill $1\frac{13}{16}$-in. holes and ream to $1\frac{15}{16}$ in. This condition was brought about by the awkward positions from which some of the drilling had to be done and the difficulty experienced in operating big motors from such positions.



TYPICAL "OLDMAN" USED FOR DRILLING CHORDS

Throughout the winter the cold weather materially interfered with the drilling; the usual trouble with freezing of the motors was experienced, and the "soups" often froze before reaching the drill points. Alcohol was introduced freely into the pipe line both at the air tank and the hose connections, but during extreme cold snaps it was of little avail in lessening the number of "freeze-ups." Maintaining a coal fire every 30 ft. under the main air line did more to overcome freezing than any other expedient tried. But for the fact that a vertical air tank was employed it would have been impossible to keep the line open.

The "soups" consisted of a cheap grade of soap dissolved in water. During the cold weather it was necessary to make this in small quantities and keep it hot. To keep the mixture from freezing, and at the same time thin enough for use, was a problem. It was found that the greater the quantity of soap the slower was the freezing; but beyond a certain point the mixture became too thick to flow easily to the drill point and often froze in the spout of the squirt cans.

It was planned to lay out the holes with a template; but after finding that there was a great probability of bad holes, due either to carelessness in placing the template or a slipping of the drill, the plates were bolted in position and the holes drilled through the new plates. Drilling through the new plates with thick and freezing soups caused burned drills to be a much too common occurrence; but the speed with which holes were drilled in this manner more than balanced the expense due to damaged drills.

Special types of "oldmans" were made of channels and angles. The general type is shown in the accompanying sketch. The channels were in two lengths—one about 3 ft., for use on the top chord, and the other about 7 ft., for the lower chord. The former ordinarily covered 17 holes, the 7-ft. length about 28 holes.

The 8539 holes were drilled with 36 drills. The average thickness of the steel was $\frac{7}{16}$ in. Each drill was repointed about six times, and it was possible to use the drills until they were cut down to about $1\frac{1}{2}$ in. in length.

*3 Cherry St., Ft. Trumbull Beach, Milford, Conn.

Owing to bad locations of many of the holes, high-speed drills could not be economically employed, and "Little Giant" No. 2 motors with Standard Tool Co. No. 6224 drills were used throughout and gave very good service. The total labor cost was $622.37, or about 7¼c. per hole. The cost of material may be estimated at not more than ¼c. per hole, making the holes average about 7½c. each. During the cold weather two men turned in on an average of from 70 to 90 holes a day. The best count made in one day of eight hours was 200, at a labor cost of $7.50, or 3¾c. per hole. The record for any period of time was 971 holes in 44 hr., at a labor cost of 4.37c. per hole.

Quick Solar Reduction by Slide Rule

Engineers and surveyors do not make as much use as they should of direct solar observations by transit to locate the meridian. The principal reason for this is the fact that the formula for the reduction is a little involved, and is easily forgotten. Recently a slide-rule was developed for solving this equation and the process is so much shortened that it may become popular. Accuracy is obtained by making the slide-rule scales 20 in. (50 cm.) long.

The front face of the slide-rule—a duplex type—carries 7 scales which solve the equation

$$\cos \text{Azimuth} = \frac{\sin d}{\cos h \cos l} - \tan h \tan l$$

in which d = declination, l = latitude, h = altitude of the sun, ascertained by observation.

The scales on the front of the rule are, in order downward: Regular *D* scale; *sin d* from 2° 22′ to 24°; *cos l* and *cos h* scale from 0 to 84° 15′; regular *C* scale in the middle of the slide; *tan* scale from 5° 43′ to 45°; inverted *tan* scale from 20° 50′ to 55° and at the bottom an enlarged *cos* scale with adjacent scale of equal parts, for angles from 0° to 60°. Either this scale or the *cos l* and *h* scale in conjunction with the *C* scale is used for getting the final result, the azimuth angle, from the *cos Azimuth* which is obtained by subtracting two slide-rule results.

The following example to illustrate the use of the rule is given by B. J. Campbell of the Keuffel & Esser Co., makers of the rule:

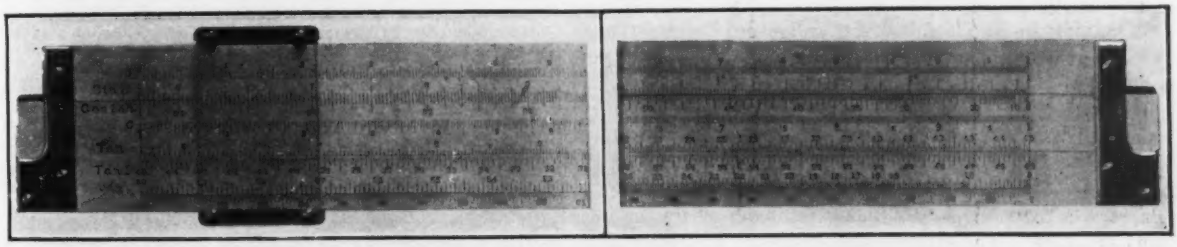
Latitude 40° 45′ N.; Longitude 74° 1′ W.; date Mar. 18, 1915, 3:57 p.m.,; observed altitude 23° 49′; horizontal circle 156° 30′. Required the bearing angle with the meridian of an east station at zero of the horizontal circle.

The refraction correction to the observed altitude is,

$$\frac{0.96}{\tan h} = 2.2'$$

which is to be subtracted from the observed altitude, making the corrected altitude 23° 47′. The declination, taken from the ephemeris as —1° 15′ 49″ is corrected for change from Greenwich noon by multiplying the hourly correction by the elasped time between noon plus the hour-angle of longitude of the place of observation west of Greenwich, in this case 59.3″ × (4 + 19) = 8′ 50″, making the corrected declination —1° 7′. This gives all the quantities necessary for solving the formula. The first part of the equation is solved by setting opposite 1° 7′ on the scale of sin d* the value cos 23° 47′ on the top scale of the slide, then moving the runner to the 0 index of the slide and again shifting the slide to bring cos 40° 45′ under the runner. The index of the slide then reads 281, which is to be read as —0.0281. The second half of the formula is obtained by setting 23° 47′ on the tan scale opposite 40° 45′ on the tan inverted scale just below, and reading opposite the left-hand index of the tan inverted scale the value 3798 on the C scale on the middle line of the slide. This is to be read as 0.3798. Subtracting the second term from the first gives —0.4079 as cos Azimuth. Setting this value on the C scale we read on the cos l and h scale the angle 65° 56′. This is measured from the 180° point, as the cosine is negative; since the observation is in the afternoon, the actual azimuth is 245° 56′. Subtracting the reading of the horizontal circle gives the true bearing of the zero point as 89° 26′.

The slide-rule is of still further interest because of the equipment on its reverse side. This has the regular *A*, *B*, *C* and *D* scales (20 in. long), and on the middle of the slide an inverted *C* scale; and a pair of scales for reducing stadia observations, one of them a 34-in. scale for ($\frac{1}{2}$ *sin* 2 *a*), and the other a 6-in. scale for ($\cos^2 a$), giving respectively the elevation and the horizontal correction.



FRONT OF SLIDE-RULE FOR REDUCING SOLAR OBSERVATIONS FOR AZIMUTH

A 20-in. rule, of duplex construction. The rear face carries regular slide-rule scales and a pair of stadia reduction scales

Placing the Concrete Lining for Reservoirs

In putting the lining on the interior slopes of a rectangular reservoir of 14,000,000-gal. capacity at Omaha, Neb., the concrete is being placed in horizontal bands instead of up and down the slopes, as is the usual practice. The bands are about 5 ft. wide. Each one is completed around the reservoir on the day it is commenced. The reason for adopting the horizontal bands was that it permitted the use of a moister mix of concrete than is practicable with strips extending up and down the slopes.

The concrete is delivered in place by means of a chute, and the mixers are so placed as to minimize the distance required to transport it. After the completion of the slope work, a parapet wall 9½ ft. high will be built, a small hoist being used to raise the concrete to the top of the forms.

The same method of lining the slopes was employed last year for a reservoir of 11,000,000-gal. capacity at the Walnut Hill pumping station. Two concrete mixers were used, placed half-way along the east and west ends and elevated sufficiently to deliver the concrete by chutes to

*The sin d scale does not go below 2° 30′; but for smaller angles ½ sin 2d is equal to sin d, with very small error, and as one of the scales on the back of the rules gives ½ sin 2d, the present example uses this scale instead of sin d.

any desired point on the slopes. For the floor the chutes delivered the concrete to the foot of the slope, from which point it was distributed by wheeled carts.

The parapet walls in this case were only 2 ft. high. They were built after the slope lining had been placed, and the concrete was spouted directly from the mixers into the forms. The mixers for this reservoir being about 35 ft. above the ground, the tracks for their charging skips were extended downward for this distance, so that they could be loaded at the lower level and deliver the charge to the mixer at the higher level.

The work was done under the direction of George T. Prince, Chief Engineer of the Metropolitan Water District of Omaha. The district does all concrete work by its own force instead of by contract.

Rapid Erection of Temporary Timber Bridge

By S. Cameron Corson*

The old covered wooden bridge over the Schuylkill River between Phoenixville, Chester County, and Mont Clare, Montgomery County, Pennsylvania, was destroyed by a fire of unquestioned incendiary origin during the night of May 13 and 14, 1915. A few days before, petitions signed by leading citizens of the two boroughs, as well as by many other interested persons living adjacent to the bridge, were sent to the commissioners of Chester and Montgomery Counties requesting a new bridge. At a joint meeting of the commissioners the petitions were ignored because of "lack of funds." Then came the fire.

A contract for a temporary bridge at the site was awarded to the H. A. Bender Construction Co. for $7850, to be completed in thirty-three working days from the signing of the contract. Work was started June 21, 1915, and the bridge was opened for public use July 10, only 19 days later. There is a bonus of $20 per day for the remainder of the allotted time.

The view in Fig. 1 shows the bridge near completion. Fig. 2 gives the details of construction. There are 18 spans, 30 ft. c. to c., and the roadway is 16 ft. between guard rails. The design consists of floor plank laid diagonally on transverse joist which frame across I-beam stringers supported by timber bents. These bents are 6 ft. wide, 30 ft. long and 9 ft. 6 in. clear above mean water. There is a total of about 110,000 ft., b.m., of timber in the structure. The bridge was designed by Oscar E. Thompson, consulting engineer, Phoenixville, Penn.

*Borough Engineer, Norristown, Penn.

Computation of Survey Traverses

To the discussion of the use of traverse tables in *Engineering News*, May 27, 1915, Horace Andrews, of Albany, N. Y., contributes the following:

Why is it not better to use a good table giving the natural sines and cosines and have the multiplication carried on independently?

Many tables exist giving natural sines and cosines to five places, and one, that of Prof. W. Jordan, recently issued in its second edition, gives seven places for each 10 sec. of angle.

There are three very good tables for multiplication—Crelle's, Zimmerman's and Peters'; of these, the last named

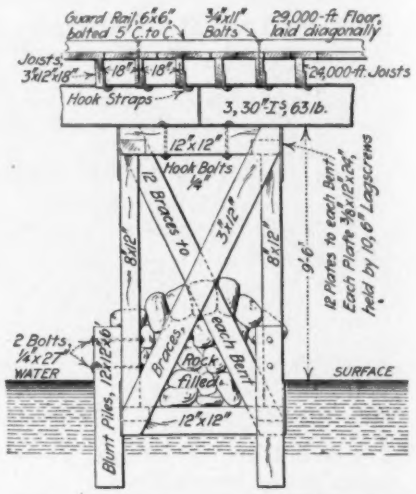


FIG. 2. SIDE ELEVATION OF PHŒNIXVILLE TIMBER BRIDGE AT SUPPORTING BENT

seems to be the best for use with traverse work. It gives products of every four-place number with all two-place numbers to 100. This large work costs 15 marks, while Zimmerman's, which is equally extensive, though not so convenient as Peters', costs only 5 marks.

Where a computing machine is available, Jordan's tables and the machine could profitably be used. If a comptometer is used the multiplication given by Peters' tables would be a help with the machine.

I have frequently used the excellent five-place tables of Gauss for logarithmic computation, using a blank form specially ruled with printed headings, and then checked my work with the tables of natural sines and cosines using Gurden's tables; or those of Defert, which I prefer and regard as the best of the various traverse tables for ordinary use.

The Defert tables give for each minute of arc nine multiplications, from 10 to 90, with special tables for use when an angle less than 1 min. of arc is given. In all cases it is very necessary to check the numerical work of traverse computation by some means, and the best way seems to be to have one

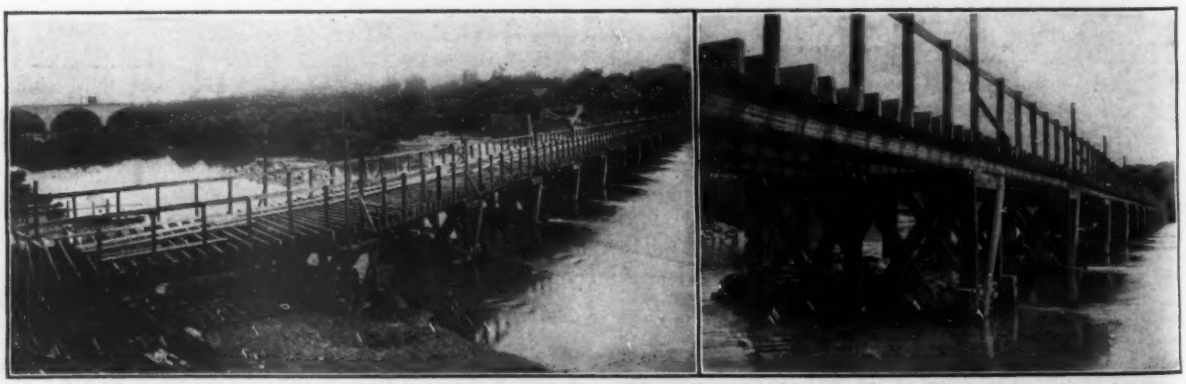


FIG. 1. TEMPORARY BRIDGE ACROSS SCHUYLKILL RIVER BETWEEN PHŒNIXVILLE AND MONT CLARE

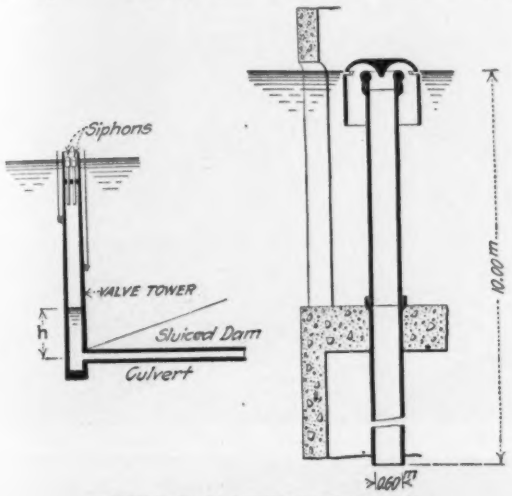
computation carefully made by the use of five-place logarithms and another by the use of traverse tables, or some other similar method as previously referred to.

Mr. Andrews states that four-place traverse tables will amply suffice for a large amount of ordinary field work. There are, he writes, at least 16 different traverse tables in existence.

Siphon Spillway for Power Dam

By T. K. Mathewson*

What is thought to be the first use of siphon spillways in America as the main discharge of a power reservoir was embodied in a recent design of the writer's. This type of spillway has found considerable use in



POWER-DAM SIPHON SPILLWAY

hydraulic works[1] and seems destined to wider application, so many advantages does it possess.

Shortly before the writer left Mexico, about a year ago, he studied a stream not far from Mexico City to report on a proposed hydro-electric development. A reservoir of 90 million cu.m. capacity (1950 million cu.ft.) formed part of the project finally decided upon for the initial development of 40,000 hp. The dam was to be a sluiced earth fill with masonry outlet and tower, similar to the Calaveras Dam, described in *Engineering News,* Oct. 1, 1914, p. 629. The depth of water would have been 45 m. (147.5 ft.). Every feature at the reservoir was favorable, except that the formation at the dam site was not hard enough to spill upon. Barrancas near by showed that the material would slowly but surely be eroded.

The writer saw that the culvert and tower might discharge the rainy-season floods, if only water could be got into the tower fast enough. There was no room at the top of the valve tower for an ordinary spillway of sufficient length, and it was believed that the well-known idea of the discharge of automatic sewer flush tanks could be applied to give the large flow without great rise in reservoir level. It was found that 16 vertical cast-iron pipes of 60 cm. (23.6 in.) diameter could be placed in the valve tower and would give the needed rate of discharge. The accompanying sketch shows the general scheme, though it does not give some details as finally worked out. Each pipe has a cast-iron hood, like those used in the flush-tank siphons, with a ring fitting into the upturned pipe bell to give the proper shape. Only one discharge rate had to be considered, since the siphons delivered their maximum or nothing. On account of mild climate, there was no chance of ice on the reservoir.

Probably there are not very many reservoirs where this design would be useful, but it was well worth considering in this case. Unfortunately, the construction has been indefinitely postponed due to the internal disturbances of that unhappy country.

*206 I. W. Hellman Building, Los Angeles, Calif.

[1]See "Movable Dam Crests," "Engineering News," June 4, 1914, p. 1264; "The Largest Pumping Plant in the World," July 9, 1914, p. 105; "Siphon Canal Locks," Oct. 13, 1910, p. 398, and Nov. 17, 1910, p. 530; "Siphon Spillways in Europe," Apr. 20, 1911, p. 467.

Track-Raising in Building a "Hump" Station, New York Elevated Lines

In third-tracking the elevated railways of New York City, which work is now in progress, at many stations it is impossible to spread the tracks so as to admit island platforms between the tracks. There is always width enough to admit the center track, and in fact portions of

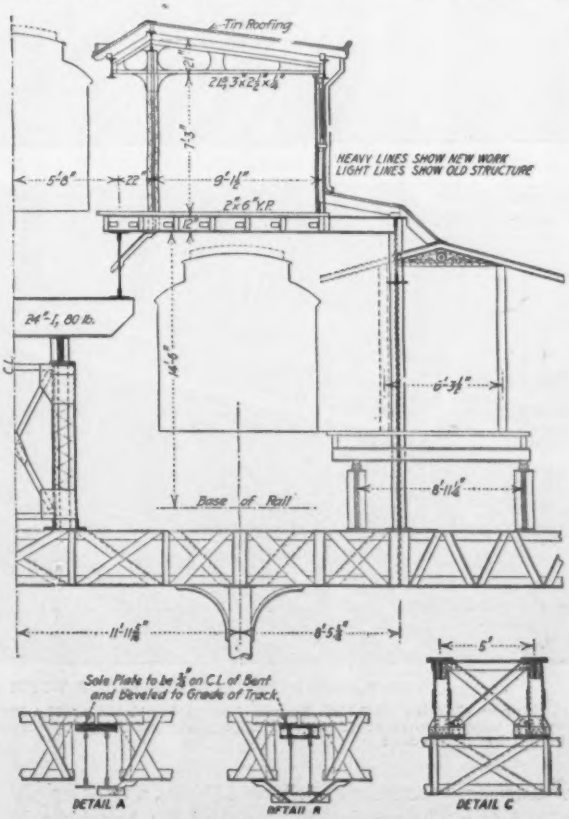


FIG. 1. CROSS-SECTION OF ELEVATED STRUCTURE AT STATION AND DETAILS OF EXPRESS INCLINE

this track were in place. To give access to the center track where island platforms were not feasible, platforms are being built at clearance height over the outer (local) tracks, and the center track is raised correspondingly, forming a long hump.

On the Ninth Ave. line a center track has existed for 20 years past, but new express stations are being built, most of them of the hump-station type. It is necessary to jack up the center track and its girders to form the hump. A typical job of this kind was done at 145th St. and Eighth Ave.

Here the hump construction comprises 9 new plate-girder spans at the station and 31 old lattice-girder spans raised to form the inclines on either side, 142nd to 148th St. The spans range from 43 ft. to 55½ ft., a total length of 1772 ft. The maximum height of the hump track above its old level is 12 ft. 3 in. The approach grades are 2.96 and 2.98 per cent.

During the construction of the incline the old center track was abandoned. After removing the track material, the bracing between the old track girders was cut out and the girders spread apart, so that the bents of the hump could be erected between them. Fig. 1 shows in detail the means by which the elevation of the center track was accomplished. At the starting and ending points of the incline packing plates (detail *A*) were placed on the existing cross-girders, of a thickness sufficient to raise the track girders to the new grade. The next form of support for the track stringers in their new location is illustrated by detail *B*, which shows a built-up seat. Detail *C* shows the general type of supporting bent used thereafter. Where the old truss girders were used in the construction they were braced to the bottom of the cross-girders by angles and kneebraces.

FIG. 2. EXPRESS INCLINES BUILT WITH OLD LATTICE AND NEW PLATE GIRDERS

Upper—Incline at 145th St. station on Ninth Ave.; the lattice girders of the old center track were used except at station proper, where there are nine spans of plate girders. Lower—Incline at Eighth St. station on Third Ave.; second deck of station being erected

The new material was delivered on the street in the order required for erection and hoisted directly to position by means of a sliding traveler of 6 tons' capacity, which rested directly on top of the longitudinal track girders of the express track (as shown in Fig. 3), where the work is under way. The traveler was equipped with a 40-hp. double-friction-drum electric hoist operated by a 550-650-

volt motor, current being taken direct from the contact rail on the structure. After setting bents, the track girders were placed in position on top of the bents and the sliding traveler moved forward to the next panel-point, where the operation was repeated.

The express-station and express-platform steelwork also was erected by this traveler when the site was reached. There is an express platform 12 ft. 4 in. wide by 350 ft. long on each side of the express track, one for northbound travel and the other for southbound. The platform is reached by two stairways located north and south of the old or lower-level station. The lower platform of the stairs is supported by a cantilever extension outside the

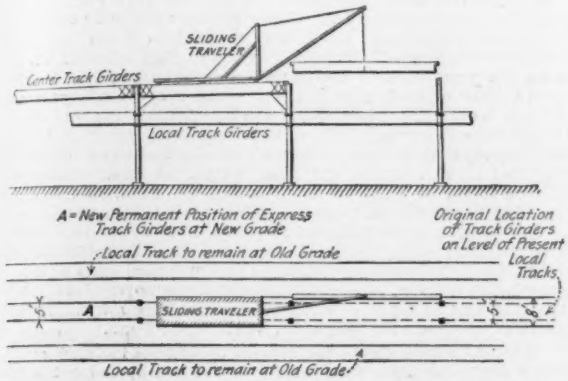

SLIDING TRAVELER
Center Track Girders
Local Track Girders
A=New Permanent Position of Express Track Girders at New Grade
Original Location of Track Girders on Level of Present Local Tracks
Local Track to remain at Old Grade
SLIDING TRAVELER
A
Local Track to remain at Old Grade

FIG. 3. METHOD OF ERECTING STRUCTURAL STEEL OF INCLINE

local platform. The upper platform of the stairs is supported by columns resting on top of the existing platform girders. The stairways connect with the platforms by a bridge 8 ft. 6 in. long.

The entire construction work, including the station, was done for the Interborough Rapid Transit Co. by the Snare & Triest Co. W. P. Rothrock was engineer in charge for the contractor and J. M. Ryan was assistant engineer. The structure was designed by the engineering department of the Interborough Rapid Transit Co., of which George H. Pegram is chief engineer, F. W. Gardiner, principal assistant engineer, and S. Johannesson, assistant engineer.

Controlling the Water-Supply to a Closed Tank

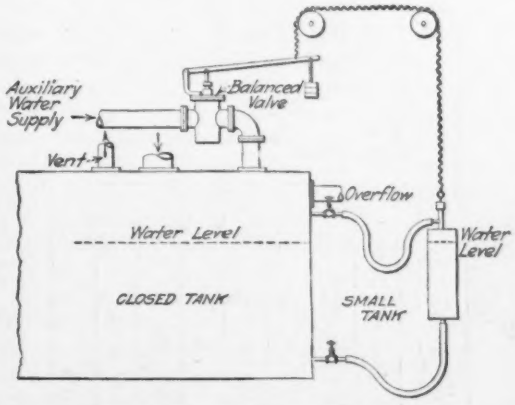
By B. C. Luce*

A simple and effective method of controlling the water supply to a closed tank without employing inaccessible devices like floats is shown in the accompanying sketch.

The device is well adapted to any service requiring a nearly constant water level—such as a boiler feed tank supplied by condensed steam from traps and with an auxiliary pressure connection automatically controlled.

The condensate from traps enters the closed boiler feed tank through a pipe marked "Main Supply." The auxiliary water-supply enters through a smaller pipe and is controlled by a balanced valve. This valve is operated automatically by a counterbalanced lever and the small cylindrical tank (about 8x20 in.) connected to the valve lever by a plumber's chain passing over pulleys. The two tanks are connected through flexible tubing at their tops and bottoms. The water level will be the same in both tanks.

A lowering of the water level decreases the weight of the small tank so that the counterweight pulls it up, opening the valve of the auxiliary water-supply. As the



CLOSED-TANK WATER-LEVEL CONTROL

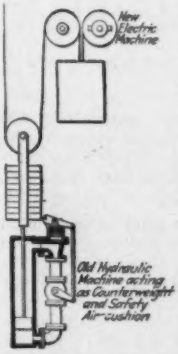
tanks fill, the small one becomes heavier and heavier until it overbalances the counterweight and closes the auxiliary-supply valve.

The limits of the water levels are to be determined by the vertical travel of the small tank, which in turn is determined by the length of the valve lever, the motion of the valve stem and the point of attaching the chain to the lever. The adjustment for proper amount of counterweight and sensitiveness of the device is easily determined by experimenting with different weights.

*Figardo, Porto Rico.

NOTES

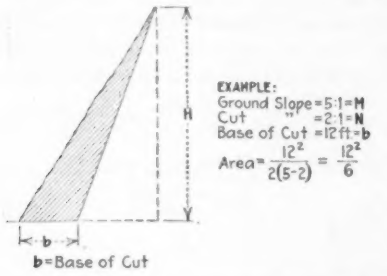
Converting Old Hydraulic Elevators—A number of old hydraulic elevators have been changed by C. R. Pratt, Consulting Engineer, of New York City, from their uneconomical arrangement to secure the advantages of electric operation. One of the methods devised by Mr. Pratt is shown in the accompanying diagrammatic sketch. The old underbalanced car is used and the old hydraulic equipment is undisturbed, or is used with a balanced-piston and speed-control choke valve in the circulating pipe for air, oil or water. The electric hoist can be put below by adding grooves to the winding sheave.



CONVERTED HYDRAULIC ELEVATORS

Inspection of Automatic Sprinklers—Sprinkler systems are examined every three months by the various inspection bureaus throughout the country. Experience has demonstrated that it is not necessary to make periodical tests; visual observation of experts has been found sufficient to insure the detection of faults which may impair efficient functioning. Renewing or testing the operative parts of sprinkler heads is quite unnecessary under average conditions. Under conditions which might affect the stability of the solder holding together the operative parts of the sprinkler, the sprinklers are carefully watched and sample devices removed every few years and tested to determine the condition of the solder. The condition watched is what engineers doing this work term "selective corrosion."—I. G. Hoagland, Secretary National Automatic Sprinkler Association.

A Table for Computing the Area of Side-Hill Cuts—The accompanying table of formulas has been found particularly convenient for computing the area of cuts in side-hill ground, knowing the slope of the ground and the slope of the cut.



SLOPE OF GROUND	SLOPE OF CUT ½:1 H	½:1 AREA	1:1 H	1:1 AREA	1½:1 H	1½:1 AREA	2:1 H	2:1 AREA
½:1								
1:1	2b	b^2						
1½:1	$\frac{2b}{2}$	$\frac{b^2}{2}$	2b	b^2				
2:1	$\frac{2b}{3}$	$\frac{b^2}{3}$	b	$\frac{b^2}{2}$	2b	b^2		
2½:1	$\frac{2b}{4}$	$\frac{b^2}{4}$	$\frac{2b}{3}$	$\frac{b^2}{3}$	b	$\frac{b^2}{2}$	2b	b^2
3:1	$\frac{2b}{5}$	$\frac{b^2}{5}$	$\frac{b}{2}$	$\frac{b^2}{4}$	$\frac{2b}{3}$	$\frac{b^2}{3}$	b	$\frac{b^2}{2}$
3½:1	$\frac{2b}{6}$	$\frac{b^2}{6}$	$\frac{2b}{5}$	$\frac{b^2}{5}$	$\frac{b}{2}$	$\frac{b^2}{4}$	$\frac{2b}{3}$	$\frac{b^2}{3}$
4:1	$\frac{2b}{7}$	$\frac{b^2}{7}$	$\frac{b}{3}$	$\frac{b^2}{6}$	$\frac{2b}{5}$	$\frac{b^2}{5}$	$\frac{b}{2}$	$\frac{b^2}{4}$
4½:1	$\frac{2b}{8}$	$\frac{b^2}{8}$	$\frac{2b}{7}$	$\frac{b^2}{7}$	$\frac{b}{3}$	$\frac{b^2}{6}$	$\frac{2b}{5}$	$\frac{b^2}{5}$
5:1	$\frac{2b}{9}$	$\frac{b^2}{9}$	$\frac{b}{4}$	$\frac{b^2}{8}$	$\frac{2b}{7}$	$\frac{b^2}{7}$	$\frac{b}{3}$	$\frac{b^2}{6}$
5½:1	$\frac{2b}{10}$	$\frac{b^2}{10}$	$\frac{2b}{9}$	$\frac{b^2}{9}$	$\frac{b}{4}$	$\frac{b^2}{8}$	$\frac{2b}{7}$	$\frac{b^2}{7}$
6:1	$\frac{2b}{11}$	$\frac{b^2}{11}$	$\frac{b}{5}$	$\frac{b^2}{10}$	$\frac{2b}{9}$	$\frac{b^2}{9}$	$\frac{b}{4}$	$\frac{b^2}{8}$
6½:1	$\frac{2b}{12}$	$\frac{b^2}{12}$	$\frac{2b}{11}$	$\frac{b^2}{11}$	$\frac{b}{5}$	$\frac{b^2}{10}$	$\frac{2b}{9}$	$\frac{b^2}{9}$
7:1	$\frac{2b}{13}$	$\frac{b^2}{13}$	$\frac{b}{6}$	$\frac{b^2}{12}$	$\frac{2b}{11}$	$\frac{b^2}{11}$	$\frac{b}{5}$	$\frac{b^2}{10}$
7½:1	$\frac{2b}{14}$	$\frac{b^2}{14}$	$\frac{2b}{13}$	$\frac{b^2}{13}$	$\frac{b}{6}$	$\frac{b^2}{12}$	$\frac{2b}{11}$	$\frac{b^2}{11}$
8:1	$\frac{2b}{15}$	$\frac{b^2}{15}$	$\frac{b}{7}$	$\frac{b^2}{14}$	$\frac{2b}{13}$	$\frac{b^2}{13}$	$\frac{b}{6}$	$\frac{b^2}{12}$
8½ 1	$\frac{2b}{16}$	$\frac{b^2}{16}$	$\frac{2b}{15}$	$\frac{b^2}{15}$	$\frac{b}{7}$	$\frac{b^2}{14}$	$\frac{2b}{13}$	$\frac{b^2}{13}$
9:1	$\frac{2b}{17}$	$\frac{b^2}{17}$	$\frac{b}{8}$	$\frac{b^2}{16}$	$\frac{2b}{15}$	$\frac{b^2}{15}$	$\frac{b}{7}$	$\frac{b^2}{14}$
9½ 1	$\frac{2b}{18}$	$\frac{b^2}{18}$	$\frac{2b}{17}$	$\frac{b^2}{17}$	$\frac{b}{8}$	$\frac{b^2}{16}$	$\frac{2b}{15}$	$\frac{b^2}{15}$

TABLE FOR COMPUTING AREA OF SIDE-HILL CUTS

The table may also be plotted as a diagram, using either the ratio of the slope of the ground or the angular slope of the ground as abscissas and the quantity of excavation as ordinates.—F. W. Groves, Civil and Hydraulic Engineer, Kelowna, B. C., Canada.

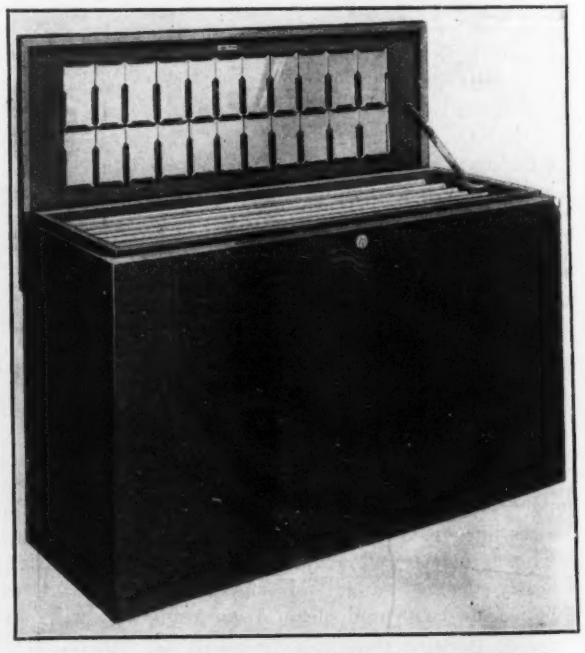
Flushing Out 40 Years' Accumulation of Sand in the Mains of the Milwaukee Water-Works—Over 51,000,000 gal. of water were used during 1914 in Milwaukee, Wis., in an effort to clear the water mains of an accumulation of sand carried into the system during forty years of operation. A special crew, under the supervision of the superintendent of water mains division, was engaged for several months, and the mains were flushed at 577 different points, the total amount of water used being nearly 35,000,000 gal. In addition to the work done by this special flushing crew, considerably more flushing than usual was done by the hydrant inspectors and mains-repair crew, which brought the total amount of water used to nearly 52,000,000 gal. While considerable deposits were removed in this way, a large number of meters were "sanded," and a considerable number of complaints of dirty water were received, owing to the fact that the flushing was done during the day and the house services used while the water was in a state of agitation. It has accordingly been recommended that the flushing hereafter be done at night while the house services are inactive.

In Tearing Down the Champlain Building, Chicago, the structural steel and other heavy wreckage is handled by a steel stiff-leg derrick mounted on the roof of an adjacent taller building. The new structure will form an extension of this building, and the derrick will be used in its erection.

The Longevity of Cast-Iron Pipe when used for plumbing fixtures has been demonstrated in the destruction of the old Astor House, New York City, to make way for the new Broadway subway. The Astor House was erected in 1834 and the soil pipe, cast in the foundry of the J. L. Mott Co., New York, is still practically as good as new.

Lowering a Water Main Under Pressure—It was recently necessary to lower 1000 ft. of a 36-in. water main in Waterbury, Conn., to conform to the new grade of the street under which it lies. As the main to a high-service pumping station branches off from this section, it was necessary to do the lowering before starting the branch line in order to avoid additional expense. To discontinue the use of the 36-in. pipe, which is the main line from the largest reservoir, for the length of time required for this work, would have resulted in great inconvenience. So it was decided to lower the main without shutting off the water by excavating a trench alongside the pipe, cutting away under each length, but leaving earth piers at each joint. Then, while surveyors kept track of the levels, the piers were weakened until the weight of the pipe line caused a little settlement. Working up and down the line in this way, the pipe gradually came down to the bed blocks, which had been set to the exact elevations. Owing to the pressure of about 100 lb. per sq.in. on this main and the proximity of two railroad tracks, the operation was attended with some risk and required close attention. Under the constant supervision of Assistant Engineer Charles W. Eddy, the work went on regularly and systematically and was completed without accident. After driving up the lead joints the line was as tight as ever.—From the 1914 Annual Report of R. A. Cairns, City Engineer, Waterbury, Conn.

Vertical Filing Cases for Storing Drawings in large quantities are being made in a variety of designs by the Art Metal Construction Co., of Jamestown, N. Y. The accompanying illustration shows a "plan-file" case adopted by the valuation department of the Interstate Commerce Commission and by several railroads. It is 30 in. deep over all, 6 in. longer and 8⅛ in. higher than the drawings to be filed. It holds



VERTICAL DRAWING FILE USED BY INTERSTATE COMMERCE COMMISSION

6000 tracings. There are 18 pockets formed by steel partitions with springs between to hold the drawings always flat and upright. The drawings are laid in tough-paper folders for filing in the pockets. Three to six folders can be used in a pocket and up to 60 tracings per folder. The index cards on the inner face of the cover give easy access to the contents of the file. The side walls may be single steel or double filled plates, as desired.

Editorials

Mortar Beds for Brick and Stone Pavements

Any practice that has been established for many years generally has some substantial reason for existence, and in such a case mere change does not necessarily mean progress. Particularly is this the case with street pavements. One has but to read old treatises on pavements to see how thoroughly the principles of good paving practice were understood years before engineers in general could be induced to apply those principles.

A good example of this is the wood-block pavement, introduced both in this country and England about 1837. By 1845 English municipal engineers had conclusively proved that the only proper way to lay a wood pavement was to use treated blocks on a concrete foundation, yet for many, many years, American engineers, notwithstanding the advice of experts both in this country and abroad, persisted in experimenting with every conceivable combination but the correct one. Only within the last twenty years, in general, have wood-block pavements in this country been properly constructed. The same thing is true of the use of concrete foundations for brick and stone-block pavements.

In view of this accumulated experience, any radical departure in practice from that which has been long established should be thoroughly tested before it is adopted, especially if the established methods have given satisfactory results. Such a departure from standard practice is the present tendency to experiment with a mortar bed for a granite-block pavement, and the laying of brick on a green concrete foundation without a sand-cushion course, as described in *Engineering News* of July 22.

So far as granite block is concerned, the omission of the sand-cushion course is neither recent nor novel. It was tried and discarded before most engineers of the present day began to practice. The sand-cushion has been retained because, with a rigid, unyielding material for the pavement surface, a certain amount of resiliency in the bedding is essential. This resiliency is furnished by a thin layer of clean sand, which, although practically incompressible, has by no means the rigidity of concrete. The necessary layer of sand may be very thin, perhaps with well-squared blocks ½ or ¾ in. is enough, although the best practice is a minimum of 1 in.; to omit it entirely is an experiment, the success of which cannot be demonstrated except by the years of service to which as yet it has not been subjected.

With wood-block and asphalt-block pavements the same arguments do not apply, for here we have a material that has a certain amount of inherent resiliency. In the case of a wood-block pavement the sand cushion has no other purpose than to take care of inequalities in the depths of individual blocks. This, to be sure, is one purpose but not the only purpose of a sand cushion in granite-block and brick pavements.

It has been claimed that the use of a mortar bed in place of a sand cushion prevents the failure of the pavement by the washing out of the sand. But what paving engineer ever heard of a properly constructed granite-block pavement that failed in this manner? On the other hand, it may be claimed that a very lean dry mixture of cement and sand does not set up into a hard rigid mortar, but has stability while still retaining a certain amount of elasticity or resiliency. But the thin sand cushion has these qualities also, so why use cement at all?

Attention is called to this matter because the reader may suppose that in view of these departures from ordinary practice having been described in *Engineering News* they are thereby approved by it. It is the business of a technical journal, however, to publish the news of what is actually being done by engineers, and it does not follow by any means that the new devices or methods described are approved by the editors. This may or may not be the case; and with respect to the laying of block pavement on a mortar bed it is merely desired to call attention to the fact that its success remains to be demonstrated.

Investigating the Capsize of the Steamer "Eastland"

The numerous official inquiries into the causes of the "Eastland" disaster at Chicago (no less than eight at one time being under way or planned) have resulted, as was to be expected, in a great deal of irrelevant matter. The most important testimony given before the coroner's jury was that of the assistant engineer on the "Eastland" to the effect that there were five water-ballast tanks on each side of the "Eastland," and that when the boat capsized, he and the chief engineer had been for some time engaged in trying to bring the vessel back to an even keel by pumping water into tanks 2 and 3 on the wharf side of the boat and out of tanks 2 and 3 on the river side.

According to the testimony of a number of witnesses the "Eastland" was in the habit of listing to one side or the other; but it is clear that none of the engine-room force or the ship's officers had any idea that the ship was deficient enough in stability to involve any danger. Those in the engine room who were trying to fill the tanks appear to have wondered why the ship did not come back on an even keel and sent a young oiler up to see if the boat was caught against the side of the wharf. By the time he reached the second deck the boat had listed so far that water was pouring into the hatchways and he had just time enough to jump onto the wharf.

In the investigation of any such disaster as this terrible one at Chicago, the matter of greatest importance is not by any means that on which the newspapers lay greatest stress—determining the persons responsible for the disaster so that proper punishment can be meted out. Such punishment, no matter how well-deserved, cannot bring

back to life those who have perished. It is a fair question, moreover, what severity of punishment is deserved by those whose acts may have brought about a calamity, but who had no idea at the time that what they were doing threatened danger to others or punishment to themselves. The object of punishment for crime in civilized lands is not retaliation. Society does not punish the criminal to "get even" with him, but as a warning to others tempted to commit similar crimes.

The primary object of any such investigation as this of the "Eastland" disaster should be to determine the causes which brought about the disaster and to make them known in such a manner as will be most likely to prevent similar disasters in future. In the light of what has happened at Chicago it is probable that vessels used for passenger service, and especially those carrying large crowds of excursionists, ought to be designed with sufficient stability to furnish an ample margin of safety, even when all their water ballast is discharged. Indeed it may be questioned whether vessels of this class should be built with water-ballast tanks. There is certainly no such necessity on them as there is on freight steamers where some means have to be provided for making the vessel stable when it is sailing without cargo.

In the comment on the stability (or lack of stability) of the "Eastland" in the last issue, it should have been said that the metacenter (not the center of buoyancy) must be higher than the center of gravity in order that a vessel may be stable. A floating body may be stable even though its center of gravity is above its center of buoyancy. A broad flat sheet of cork, for example, might float on the water with only a quarter of its bulk submerged and would be perfectly stable even though its center of gravity were above the center of buoyancy. The metacenter is the point at which a vertical line through the center of buoyancy of a floating body intersects a vertical line through the new center of buoyancy when the body is slightly inclined from its original position. If the flat sheet of cork were turned on edge, it would not float in water without falling over. Its metacenter would then be below the center of gravity.

The metacentric height of a vessel—the distance of its metacenter above its center of gravity—was an abstract and meaningless term to the general public a fortnight ago. It is so no longer. A line of passenger steamships sailing from Chicago is advertising that the "line of stability" on its vessels is 56 in. in height, whereas on ordinary vessels it is only 14 in. in height. There can be no doubt that stability calculations and the margin of stability of vessels will hereafter have an importance in the minds of vessel owners and builders which they have never before possessed.

Pier Designs and Leases

It was not so many years ago that the shipping pier had only two variations—a timber pile substructure carrying a timber frame flooring and an earth fill inside massive masonry walls. The advent of concrete, and particularly of reinforced concrete, offered opportunities for originality in design of which the engineers engaged in this sort of work have taken full advantage. In consequence, the different types of pier construction now are so many and so varied as to warrant the text-book on the subject, which, though yet unwritten, should soon attract the efforts of some sufficiently interested expert.

As a contribution to the art of pier design the new Ninth St. piers in Cleveland, described elsewhere in this issue, are noteworthy, not because any especially new idea has been developed there, but because of the excellence with which the general principle of an earth fill inside of masonry walls has been worked out, with due recognition of the needs and peculiarities of reinforced concrete and of the value of deadmen as reinforcement against earth pressure. At the same time originality in design may be noted in the adaptation of the old pier and the heavy fill foundation to the new wall.

In other respects than in the engineering design does the Cleveland pier demonstrate that times change. The franchise contract is the last word in municipal bargaining as applied to port facilities. The steamship companies using the pier not only paid for its construction but are required to pay a more than nominal rent for fifty years, at the end of which time the pier will become the city's property. How advanced this sounds in comparison with the famous Battery pier case in New York City, where after paying only a nominal and entirely inadequate rent for over a hundred years to the city of New York, a certain millionaire family demanded, and obtained through court procedure, nearly a million dollars in lieu of a single pier franchise granted to an immigrant ancestor in the early days of the republic.

Rights-of-Way in City Streets for Public Utilities

The Supreme Court of Ohio recently rendered a decision under which in the City of Cleveland consent of abutting property owners is not necessary for the construction or extension of a street-railway line that has been approved by the City Council. The principle thus laid down is important from the legal point of view, since the Ohio State law requires such consent of property owners. The court therefore ruled that the provisions of the City Charter were superior in authority to the general state law.

Of much greater importance, however, is the ruling that makes the City Council, and not the property owners along a street, final judge as to the passage of public utilities through that street. During what may be termed the period of exploitation of public utilities in the United States by private companies, there can be little doubt that the requirement that consent must be obtained of the majority of the abutting property holders in order to extend a street-railway line or an electric-wiring system has on the whole been a beneficial safeguard. Such provisions are generally defended on the ground that the passage of such public utilities through a street may result in greatly reducing the value of the adjacent property, and that the abutting property owners therefore have a right to interpose a veto to such construction.

There is, however, a changed attitude toward public utilities at the present day. The public is now recognizing that a city's system of street railways, or electric-current distribution, or water-supply mains, exists for and should be planned for the general public convenience of the city as a whole and should not be considered merely as a money-making scheme of a franchise-holding company. It is evident, however, that if the prejudices and opposition of property owners here and there throughout the city are sufficient to block development of utilities, it

may be impossible to plan a street-railway system or an electric-distribution system so as to serve the best good of the greatest number.

Under these circumstances it seems evident that the needs of a city as a whole ought to be superior to the rights of the individual property owner, even if it should be necessary to award damages to him for the loss of value that his property may have suffered through the construction of utilities in the streets, as actually happened, for example, in the construction of the elevated-railway system in New York City. The property owners ought not to have a veto power to prevent street-railway lines or electric wires, or conduits for water or gas or steam distribution, from being carried through the streets where public convenience will best be served.

Of course, in most states radical changes in existing statutes will be necessary to bring this condition about, and this doubtless will take a long time to accomplish. On the other hand, when the case is clearly stated to the public and it is realized that the building and extension of public utilities are matters that should be determined in the public interest and not in the interest of private property owners, there can be no doubt that overwhelming public opinion will support the change.

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Why Not Sell Portland Cement by the Bag?

Twenty-eight years ago, in *Engineering News* of May 21, 1887, there was published an editorial entitled "Bags vs. Barrels for Cement." The editorial was written by the late D. McN. Stauffer and began as follows:

> It is probable that there will be manufactured and consumed this year in public works in the United States about 5,000,000 bbl. of natural hydraulic cement, worth in the market an average price of $1 per bbl. It is also safe to assume that three-fourths of this product will be packed and marketed in barrels costing about 30c. each, a package value alone of $1,125,000, which represents just so much money wasted in the destruction of the barrels as soon as their contents are used.

At that time bags were being used for the shipment of cement in the Middle West, but engineers in the East still generally specified that cement must be delivered in barrels. Mr. Stauffer, who had then recently visited the Vrynwy dam, then under construction in Wales for the water-works of Liverpool, described the use of cement in bags there as well as on numerous other important engineering works in England and on the Continent, and urged that there was no reason why bags should not be universally used for the packing of cement. It is noteworthy that at that time so little portland cement was made in the United States that it was not even mentioned in the editorial.

As every engineer knows, portland cement has displaced natural cement in the market, and the annual production is now nearly twenty times as great as the production of natural cement thirty years ago. Furthermore, the entire product, except that destined for ocean shipment, is packed in bags; yet all the cement produced still continues to be bought and sold by the barrel. The standard bag of cement contains 94 lb. of cement; and it contains this amount merely because cement was originally packed in barrels weighing 400 lb. gross. It seems worth while to raise the question whether the time has not come when the barrel as a unit may be dropped and the bag substituted in its place. In all the transactions connected with cement, from the original computations of the chemists in the laboratory until the finished cement is in place in a piece of work, calculations are continually being made from barrels to bags, and from bags back to barrels. An order for so many barrels of cement is actually counted out in bags as the cement is loaded and again as it is received.

It was easy to predict thirty years ago that the change from barrels to bags in the shipment of cement would soon be made. It would be decidedly unsafe to predict, however, at the present time when the barrel will be dropped as a unit of measurement, notwithstanding the fact that the barrel itself has well-nigh disappeared. There is a vast amount of inertia in commercial matters, and even the engineers, who have so long been accustomed to think of cement in barrels, would be loath to change to the smaller unit.

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A misleading advertisement, circulated by a reputable engineering school, concerning the alleged large and increasing demand for engineers and the munificent salaries paid for engineering talent was recently commented on in these columns. In notable contrast to such advertising is a statement in the year-book just issued by the Michigan College of Mines. With reference to employment, the book says:

> Prospective students and those responsible for them should understand that the college cannot impart traits of character. The best it can do is to help the student develop properly those characteristics which he already possesses. His advancement in his profession will depend quite as much upon his character and ability as upon his technical training, whether gained in college or out of it. Upon completion of his college course he will, if his work has been properly done, be ready to begin his career in mining. . . . Only those who are willing to do hard and continuous work, both during their course at college and in the years following, should undertake to train for a career in mining. For those who are thus willing, and who have an aptitude for engineering pursuits, the outlook is promising.

What is true of mining engineering is true of other fields. That school is pursuing the proper course toward its students which impresses on them, at the start, that their technical training will be of small value unless they possess important personal attributes which cannot be taught, and that to merit large salaries they must cultivate habits of industry and efficiency.

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"It's an ill wind that blows nobody good." The Imperial Valley earthquakes a month ago cost the inhabitants of that region a half million dollars or more; but, as shown in the news pages of last week's issue, the loss was largely due to the rattle-trap construction permitted under boom growth. Now the towns see the necessity of building better, and they are already passing restrictive ordinances. This is all the more promising because it is somewhat different from the course usually pursued by stricken communities. Too often it is assumed that calamities do not repeat themselves or that an attack of flood and fire confers the same immunity to a community as does an attack of smallpox to an individual. In the Imperial Valley there is also reported, as a result of the severe test just imposed, a stronger feeling of confidence in the value and safety of the irrigation engineering works on which depend the prosperity and even the very existence of this district.

Letters to the Editor

Quick-Closing Doors for Pressure Cylinders

Sir—Referring to the description of a quick-closing door for pressure cylinders which appeared in *Engineering News* of June 3, I would ask whether this principle has ever been applied to air locks of the "pot-lid" type for single-line bucket hoisting. Several years ago I conceived the idea of a door of precisely the design of that built by the Vulcan Iron Works, of Wilkes-Barre, Penn.

The hoisting rope was to pass through a gland set in a 5-in. or 6-in. diameter steel ball at the center of the door. The ball was to be retained by annular castings bolted to the door and the retaining packing. This would permit a limited universal motion of the door with respect to the ball; the operation is obvious. It appeared to me that with such a door the pot-lid type of lock, with its economy of air for lockage, might be made so tight as to have a decided advantage for small work. It would be interesting to know whether such a device has ever been tried.

REGINALD JACKSON.
Aluminum Ore Co.

East St. Louis, Ill., July 14, 1915.

Baltimore Tries Mortar Beds for Block Pavements

Sir—I have noticed recently several references in *Engineering News* to the use of a mortar bed under vitrified-block and granite-block pavements. We began with our contracts in Baltimore this year to lay vitrified-block pavements on a comparatively dry mortar bed. This is the case with all straight pavement work as well as track work. We use a mix of one of cement to five of sand.

The sand when delivered, coming right from the bay, is usually sufficiently moist, so that no water is added at that time. The cushion is spread on an average of 1 in. in thickness and thoroughly rolled with a hand roller, the same as in handling a sand cushion.

The brick are then laid and rolled, care being taken to roll up to the pavers each day. The culling is then done, and the brick are flushed with water, thereby adding more moisture to the cushion. Usually this procedure gives sufficient moisture for setting. The grouting is then proceeded with as usual.

Formerly when a rainstorm caught us with a sand cushion in place, with the brick rolled but not grouted, considerable damage was caused from wash, bringing the sand up in the joints. Under such circumstances, using a mortar cushion and provided the brick have been rolled no harm is done.

A great deal of our brick pavement with mortar bed has been down since about the first of March, and so far no defects have been discovered. With a sand cushion minor defects, such as grout shattering, etc., in spots, are frequently discovered within a month after the street is opened to traffic.

As to granite block, we experimented early this season with grout-filled joints and blocks on a mortar cushion in railway track crossings, with excellent results; so much so that we are now using a lean mortar cushion such as I have described under all block pavements. We believe that it is the proper thing to do, and have reached the conclusion that it is not as noisy as a sand cushion.

R. KEITH COMPTON,
Chairman and Consulting Engineer,
Baltimore Paving Commission.

Baltimore, Md., July 22, 1915.

Definition of "Vitrification"

Sir—In connection with the article on "What Is 'Vitrified' Brick or Pipe," in the current issue of *Engineering News* a footnote reference states that "the new standard definitions of terms relating to sewer pipe of the American Society for Testing Materials define 'Vitrification' as 'fusion into a hard, glassy material under high heat.'" Permit me to call attention to the fact that the definition quoted is not, as stated, among the "new standard definitions of terms" of the Society, but was presented last year by Committee C-4 on Standard Specifications and Tests for Clay and Cement Sewer Pipe among a series of proposed standard definitions, which were to be published in the *Proceedings* of the Society for one year, with a view of eliciting criticism.

At the recent annual meeting, the committee in question recommended that the proposed definition of vitrification be changed to the following form: "The consolidation of material under high heat." This recommendation was formally approved, and the definition as thus revised will be subject to adoption among the standard definitions of the Society by a letter ballot, which is about to be instituted.

EDGAR MARBURG,
Secretary-Treasurer,
American Society for Testing Materials.

Philadelphia, Penn., July 26, 1915.

Public Speaking for Engineers

Sir—Under the head of "Engineering Students Should Practice Public Speaking," Mr. Benham of Oklahoma calls attention in *Engineering News*, July 15, 1915, p. 131, to the great importance of the acquisition by engineering students of the ability to express themselves in simple, well-selected words and to show their hearers the advantage to the community at large of engineering work. I wish to express my appreciation of this statement and to call to the attention of your readers the even greater importance of a systematic effort on the part of engineers and engineering societies to present to the public, through the public press, the needs and opportunities for engineering works. Mr. Benham describes a condition which is being widely appreciated, namely, that there is no other profession which should be more interesting to the public

than engineering; but the great trouble has been that our young men have not been trained to present the results of engineering in its larger relations and aspects.

From experience with several hundred young and middle-aged engineers, I may safely assert that there is not one out of ten, or possibly one out of a hundred, who has shown the ability to write the story of an important public work in such a way as to be readable by the public. It seems as though all natural ability in expression had been destroyed by the educational methods or the technical training. For example, a young engineer writing home to his family frequently gives a most fascinating account of his work; but ask him to write out the larger facts for publication and he immediately begins a cramped, dull description of relatively unimportant details or technicalities concerning which few people care to read. He seems to lose his sense of proportion or his perspective. He is unable to adjust his mental attitude if he is conscious that the material he is writing is to be read by any one except his favored correspondent.

Successful engineers must be men of imagination, men who can picture in their own minds the great possibilities latent in unattractive surroundings. This imagination so necessary for success is often unavailable as far as giving information to the public is concerned. The preservation of the freshness of statement and clearness of vision are among the important things which seem to be lost by the time a young engineer has achieved success in other lines.

It is of the highest importance, not merely to the engineering profession, but to the public in general, that we endeavor to bring forward systematically the man who can and will write out short interesting descriptions of engineering works and achievements. Each engineering society should regard it as a duty to the public and to the profession to find among its members the man who can do this and to encourage him in every possible way to aid in the diffusion of correct information and in the education of the local public, not through technical journals, which the public does not read, but through the daily newspapers and the Sunday editions which come into millions of homes.

F. H. Newell.

Urbana, Ill., July 21, 1915.

Large Sutro Weir Under Test

Sir—The equation for the curve made use of in the Sutro weir was developed by E. T. Pratt in a letter to *Engineering News* of Aug. 27, 1914, and entitled "Another Proportional Weir." This equation is

$$x = b\left(1 - \frac{2}{\pi}\tan^{-1}\sqrt{\frac{y}{a}}\right)$$

where x = varying width, y = head above a certain datum, a = distance of datum above crest, and b = length of crest. By choosing b and a, the coördinates of the curve can be easily obtained and the curve cut out as shown in Fig. 1 herewith.

Mr. Pratt stated that the flow was directly proportional to the head, or, in other words, that

$$Q = ch + A,$$

where Q is the flow in cu.ft. per sec., c is a proportional factor, h is the height of water over the crest, and A is a corrective constant.

In connection with a thesis dealing with proportional weirs, Howard Livingston, a student at the University of California, actually built a weir of the Sutro type. A description of the weir, with the results of a test, follows:

The weir was cut out of a ¼-in. steel plate. The assumptions were: $a = {}^1/_{48}$ ft. and $b = 2$ ft. (Fig. 1).

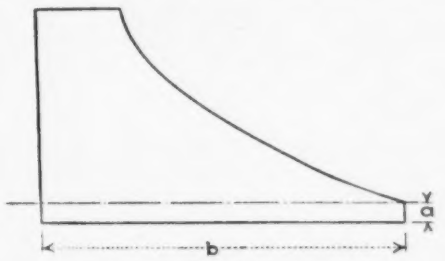


FIG. 1

It was so constructed as to fit the rectangular notch in the regular concrete weir box used in the hydraulics laboratory. Water was furnished by centrifugal pumps and a steady surface was maintained by means of baffles. The head on the weir was measured with a hook gage reading to thousandths of a foot, and the actual quantity was obtained volumetrically by timing the flow into a 7x7x12-ft. concrete tank equipped with a hook gage reading to millimeters.

By investigating the data included in Fig. 2 herewith and studying the curve plotted (head in ft. over the crest against quantity in sec.-ft.) it seems quite certain that the weir can be taken, practically, as a "proportional-

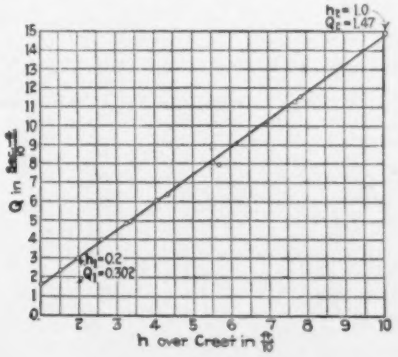


FIG. 2

flow weir." Out of the seventeen observations taken, only one point fell noticeably off the straight line, the equation of which is $Q = 1.46h + 0.01$.

The equation can be obtained quite simply from the curve by picking off two values for Q and the corresponding ones for h, then solving the two resulting equations simultaneously.

The above-described weir with a 1-ft. crest gives an approximate flow of 1,000,000 gal. per day per ft. over the weir's crest (exactly it is 950,000 gal. per day).

Ben D. Moses.

2236 Summer St., Berkeley, Calif.,
May 26, 1915.

The Novel Lever Lift Bascule Bridge over the Louisville & Portland Canal at Louisville, Ky., described in "Engineering News," July 15, 1915, p. 123, was fabricated by the Penn Bridge Co., of Beaver Falls, Penn. It was erected by the Middle States Construction Co., of Columbus, Ohio.

Additions to the Baltimore Sewage-Works

The opening of large additions to the sewage-works of Baltimore, Md., from time to time during the present year, is notable both for the nature of the additions and because the works are a part of one of the largest jobs of sewerage and sewage-disposal and storm-drainage construction ever carried out consecutively by a single city within a period of less than ten years.

Beginning in 1905, the Baltimore Sewerage Commission, under Calvin W. Hendrick, Chief Engineer, has built 700 mi. of sanitary sewers and storm-water drains, made 90,000 house connections, covered over Jones' Falls, a considerable stream in the business part of the city, erected a sewage-pumping station, and built sewage-treatment works for 600,000 people. The cost to date has been about $20,500,000.

The cost of all the work just outlined is met by the proceeds from bonds. Until recently these bonds ran for 50 years, but lately serial bonds have been issued. The interest rate has been successively 3, 3½, and 4 per cent.

The sewage-works of Baltimore consists of a grit and coarse screen chamber; three large settling tanks, each 103x420 ft. in plan, with 13 ft. of available depth; three sludge-digestion tanks, each 103x140 ft. in plan, with 13 ft. of available depth; sludge-drying beds with a total area of 40,000 sq.ft.; two revolving screens through which the settling-tank effluent passes; 12 acres of sprinkling filters; and two secondary or final settling tanks, 270x290 ft. in plan and 10 ft. deep. These works were designed to treat the sewage flow for the first few years of operation when comparatively few houses were connected to the sewers. It was deemed advisable to build additions to the tanks, filters and sludge beds only when the increase in flow made them necessary.

The additions to the works consist of 28 Imhoff tanks, four sludge-drying beds, two chambers for revolving screens, 18 acres of sprinkling filters and 16 sludge-digestion tanks. Some of the new filters and all of the sludge tanks have been in use since about Jan. 1, 1915, the sludge beds since about May 1, and it was expected that ten of the Imhoff tanks would be put in operation by Aug. 5, some of them having already been filled. The accompanying sketch and views show the Imhoff tanks and sludge beds and the sprinkling filters.

The 28 new Imhoff tanks provide for the sewage of an additional 112,000 people. They are 40 ft. in diameter and about 26 ft. deep from the sewage surface to the bottom of the sludge hoppers. Each of these tanks is designed to give two hours of sedimentation to the sewage of 4000 people and to provide a sludge capacity of about 1 cu.ft. per capita for six months.

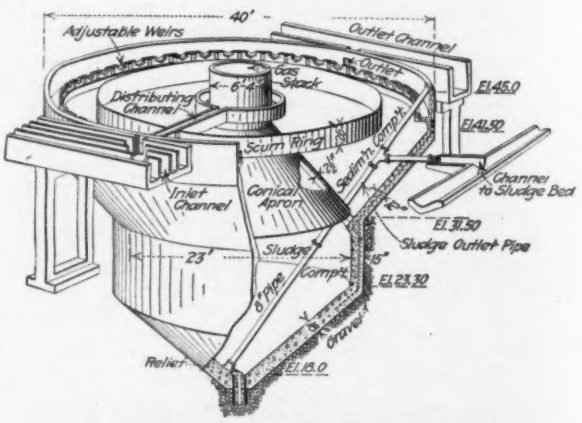
The Imhoff sludge beds have an area of about 45,000 sq.ft. and are designed to give somewhat over ½ sq.ft. of area per capita for six months. There are two beds, each 75 ft. wide. One is 404 ft. and the other is 189 ft. long. Each is subdivided by board partition into 26x75-ft. units. The beds consist of 4 in. of sand resting on 8 in. of gravel at the sides and 11 in. at the center. Beneath the center of the small dimension of each unit (i.e., 26 ft. c. to c.) is a 4-in. unglazed tile underdrain, laid in a gravel-filled trench.

Two new chambers for revolving-screens for tank effluent have been built. The screens will be built when the increased sewage flow makes them necessary.

The new sprinkling filters have an area of 18 acres; and together with the filters in operation since 1911, give a total filter area of 30 acres. The new filters are substantially the same as the old ones except that the latter had 6-in. terra cotta pipe inclosed in concrete for distribution while the new distributors are of 6-in. cast-iron pipe.

The addition to the sewage-works includes 16 new sludge-digestion tanks, one-half of them to take care of the sludge from the final settling tanks, and the other half to be used in conjunction with the three original rectangular sludge tanks. Each tank is 25 ft. in gross depth, 10 ft. of depth being in the hopper bottom. The sludge will be admitted to these tanks near their tops through an inclined 8-in. pipe set at right angles to the slope of the hopper-shaped bottom; and the supernatant liquor will be removed by reversing the flow through the same pipe. The sludge-outlet pipe, which discharges under the head of the contents of the tank, is parallel with the hopper bottom and empties into a channel or sludge distributor which leads to the sludge-drying beds.

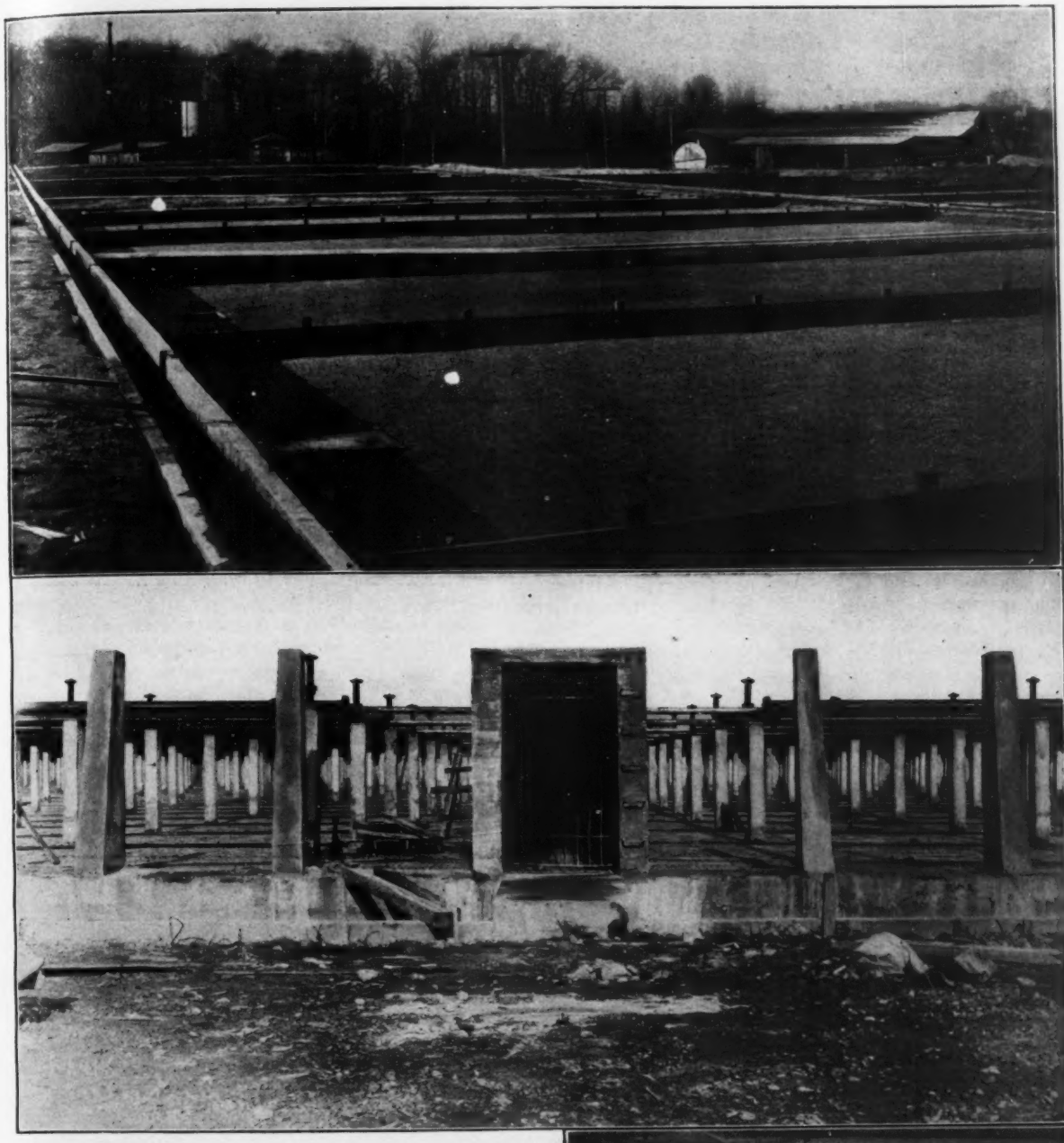
The sludge beds for these circular and original rectangular sludge tanks are four in number. Two of them are



SKETCH OF BALTIMORE IMHOFF TANK

400x100 ft. in plan and two are 486x150 ft. All are subdivided into small units by board partitions. One of the 400x100-ft. beds is an old bed, built in 1910, with its original sand depth of 36 in. reduced to 30 in. The other three beds are like the Imhoff-tank sludge beds, already described. The combined area of all the sludge beds, old and new, including also the Imhoff beds, is about 230,000 sq.ft., or about 5.3 acres.

Two of the Imhoff tanks have been adapted to activated-sludge experiments, and one of them has been provided with an anti-scum device, for testing out. In this tank the incoming sewage will strike the under side of an inclined but nearly horizontal screen stretched across the central scum compartment or gas tank, so as to break up the scum formation, keep it waterlogged, and force it down into the sludge.



VIEWS OF ADDITIONS TO BALTIMORE SEWAGE-WORKS

Top—Imhoff sludge bed. Middle—End of sprinkling filter, showing central inspection gallery, distribution and underdrainage systems, and posts to hold up dry rubble masonry end walls. Bottom—Looking along top of nearly completed Imhoff tanks; control house in left middle distance and sprinkling filters in operation in background.

The following are the principal contractors for the additions to the plant: Lane Bros. & Co., Altavista, Va., built the 18 acres of filter beds; the Standard Lime & Stone Co., Baltimore, supplied and placed the broken-stone filtering material; C. B. Clark & Co., Baltimore, Md., built the 28 Imhoff units, the 16 circular sludge tanks, and the sludge beds.

The additions were designed by Leslie C. Frank and Gustav J. Requardt under the supervision of Henry C. McRae, Division Engineer. Mr. Requardt was in charge of the construction work. Since February, 1915, when Mr. McRae resigned his position, Mr. Requardt has been acting as division engineer of the disposal plant. As already stated, Calvin W. Hendrick is Chief Engineer of the Baltimore Sewerage Commission.

Underground Pipes in New York City Streets

When the New York Rapid Transit Ry. was projected, nearly a score of years ago, it was realized that one of the difficult problems to be solved would be the underground pipes in the streets. Many engineers believed that since these pipes all had to be removed in building the railway the opportunity should be improved to construct pipe galleries in connection with the subways so that the pipes when replaced would be at all times accessible for inspection and repair and the making of service connections without tearing up the street surface.

Various plans were made for the construction of such pipe galleries, but all were finally abandoned; some because of the cost of construction and some because they proposed to utilize the space underneath the sidewalks, which aroused the opposition of property owners, who were accustomed to use this space as their own.

Therefore, after the completion of the subway itself, the piping system has been relaid over the roof of the subway and the space around the pipes filled in with earth. As described in the series of articles by Fred Lavis on the subway work, published in *Engineering News* a year ago, a special department has been established which attends to the removal and replacement of underground piping. The engineer in charge of this department, Charles N. Green, has recently made a report to Alfred Craven, Chief Engineer of the Public Service Commission, with reference to the congestion of this underground piping and its economic results.

As indicated above, a great deal of discussion took place a dozen or more years ago regarding the difficulties due to the congestion of underground piping in city streets, but little has been heard concerning it in recent years. Mr. Green's report makes clear that while conditions were bad at the earlier period, the large increase in the number and size of underground street pipes makes conditions much more serious at the present time. In the years since 1900 there has been a great extension in the underground ducts for electric wires. Many new water and gas mains have been laid, including the entire high-pressure fire-protection system of New York City.

Probably the best idea of the condition beneath some of New York City's streets is furnished by Mr. Green's statement that in order to backfill around the piping at some of these congested points after the mains have been replaced over the roof of the completed subway it will be necessary to screen the earth used for filling and flush it into place with a heavy stream of water. The following extract from his report gives figures as to the actual occupied area in the streets at some of these places:

> **There is probably not a more congested underground condition in any city anywhere than now exists in Broadway between 17th and 24th St. Restoration here, besides being excessive in cost, cannot be done in a satisfactory manner owing to the size and number of structures. With curb lines but 37 ft. apart there are 17 pipes, 8 of which are gas, 4 belonging to one company. There are four banks of electric ducts ranging from 6 to 48 holes each, and two underground trolley tracks. The total section area of pipes only is about 25 sq.ft., including duct banks about 48 sq.ft., and including also the prisms of the two car tracks, 74 sq.ft.**
>
> **At the intersecting streets, each of which brings in a considerable number of mains and duct banks, the space left for backfill will be even less. To the above areas, 17th St. adds 12 sq ft., 18th St. 21 sq.ft. and 20th St., which is about the average, 6.6 sq.ft.**

This is not the only example of such congestion in New York by any means. Mr. Green thinks that points on Third Ave. may be as badly congested, because the footings of the elevated railroad columns occupy large space in the street, and there are on certain blocks no less than 12 lines of gas mains.

It is evident that the large mileage of unnecessary mains in the streets is one cause of this excessive congestion. Under the law governing the rapid-transit railway construction, however, the Public Service Commission's engineers are required to relay all the mains which they remove from the streets, even those which are unused. Mr. Green says that the expense of relaying these needless mains amounts to an additional cost in subway construction of from $2000 to $15,000 per contract section. This, however, is by no means the worst feature of the situation. More serious is the fact that these duplicate mains occupy space which may be needed badly for other underground structures and increase the difficulty of access to the other underground piping.

New York is burdened with this great mileage of unneeded gas mains because of the mistaken economic policy which was followed by the city authorities forty years ago —the policy of creating competition in the public utility business. In pursuance of this policy, franchises were granted with a free hand to competing gas companies to lay pipes under the city streets. No less than eleven separate franchises for the manufacture and supply of gas were granted. It was even endeavored so to frame these franchises that competition between the companies holding them would be perpetual. The franchise granted to the Mutual Gas Co., for instance, specified that in case of any consolidation or pooling of interests the directors of the company should be imprisoned.

Neither this nor any other provision to prevent combination among the gas companies ever proved effectual. In 1884, at the end of a "gas war," six New York companies were combined to form the Consolidated Gas Co. Three other gas companies that still continue to do business in New York—the Standard, the New Amsterdam, and the Mutual—are controlled by the Consolidated Gas Co. through stock ownership.

The State of New York and most other states of the Union, however, have now adopted the policy of state regulation of public utility operations and have definitely abandoned attempts to perpetuate competition in this field. Unfortunately, "the evils which men do live after them." The mistaken economic policy in dealing with the gas franchises in New York forty years ago has resulted in burying under New York streets, according to Mr. Green's estimate, at least 500 mi. of useless gas mains. The dead investment in these mains constitutes part of the capital invested in the gas business; and on this basis the rates for gas supply are fixed.

There is a still more serious injury to the city, however, resulting from these buried and useless pipes. Something like 28,000 street openings are made in New York City per annum, about 60% on account of service connections. These street openings create enormous expense, delay traffic, interfere with business, and cause accidents for which the city often has to pay damages. Mr. Green says that on account of the crowded condition of the underground piping it is almost impossible to backfill these openings properly and it is impossible to restore the pavement to its original condition, thus permanently injuring an expensive street pavement.

It should be understood that most of these unnecessary mains are still in use and therefore require maintenance by the gas companies. According to Mr. Green, the reports of the gas companies in Manhattan for six years show an average maintenance charge of about $516 per mile of main, plus a charge of $389 per mile for gas unaccounted for. In the Borough of the Bronx, the average annual maintenance charge per mile of gas main is less than $200, indicating to some extent the expense to the gas companies of the congested condition under the street surface. In urging the removal of these unnecessary gas mains by the companies owning them, Mr. Green says:

> As the congested traffic conditions and the maintenance of pavement have forced the abandonment of unnecessary railroad tracks on the surface, so do the unnecessary and useless structures underground force the consideration of their abandonment. The time has come when all structures not being used or not needed by growth should be removed by the owning company. For the city this would reduce the cost of restoration, leave more room for other necessary structures, give space for repairs to sewers, water mains, etc., and reduce the cost of pavement. For the gas company it would reduce the maintenance charge, the loss due to unaccounted-for gas, the fire and explosion hazard and the amount on which a revenue must be earned.
>
> It would result in better pavements generally, less interference with business and traffic, fewer complaints, less leakage of both water and gas, easier and cheaper repairs to gas and water mains and all other structures.
>
> With the impervious pavement used today the fire and explosion hazard would be reduced and such an occurrence as that at Fifth Ave. and 23rd St. in March, 1914, would be less dangerous. Gas from leaking mains finds its way into sewers, cellars, subways, etc., sometimes following along the mains for 100 ft. or more.
>
> There is another phase of the situation which, while it only interests us indirectly, interests the city authorities to a great extent. Pneumatic mail tubes were put in the ground about 17 yr. ago, steam pipes about 35 yr. ago, and electric conduits less than 30 yr. ago, all well within the active part of a lifetime. Who shall say that in the future there will not be some conveniences found which will require still more underground space, conveniences or necessities not now known any more than was steam or high-pressure fire service 40 yr. ago. Refrigeration, the Catskill water-supply and larger mail tubes are already seeking space in certain portions of the city. May there not be some underground means found for the disposal of ashes, garbage, etc.? Assuming this to be the case, where will such structures be placed?

It is of interest to carry the discussion further even than the changes suggested by Mr. Green. Probably if an entirely new system of gas distribution were to be planned for a city at the present time, not only would the useless duplicate mains which now take up valuable space in the streets be eliminated, but the size of the mains would be greatly reduced by adopting a system of high-pressure distribution delivery through reducing valves to low-pressure feeders covering a small area or perhaps single buildings. It is likely also that the system of the future will be planned to distribute gas for fuel and not for lighting. With electric current generated at a cost of only about a half a cent per kilowatt-hour in central-power stations and with electric lamps which approach an efficiency of 1 watt per candlepower, the days of gas as a competitor of electricity for lighting are numbered. Of course, enormous quantities of gas continue to be used for lighting and probably will be so used for a long time to come, because of the many houses fitted for gas and not for electricity; and because those in control of the electric interests, who generally control the gas companies as well, maintain a high price for electric current distributed to the ordinary consumer rather than have the competition with the gas companies unduly severe.

Sooner or later, however, a change must come. Whenever the gas companies can definitely abandon the lighting field and confine themselves to the distribution of gas for fuel, they can make it at a much lower cost because relieved of the necessity of enriching it with expensive illuminants. They can distribute this gas through a system of high-pressure mains of small size with welded joints to prevent leakage, the whole representing a small fraction of the investment required for present gas-main distribution systems which being used for lighting are obliged to approximate a uniform pressure throughout the whole area covered.

The Building Data League

A new technical society, known as the Building Data League, has recently been incorporated in New York. It will be generally agreed, probably, that this is not a propitious time to start a new engineering society. Engineers are not in favor of the further multiplication of engineering organizations, and unless those promoting a new society make a strong showing as to its reasons for existence, few will be apt to join it.

The purposes of the Building Data League, however, are entirely distinct from those of the ordinary technical society. Its object is, in brief, to provide a systematic rating for the materials and appliances which are used in building. Engineers generally are familiar with the remarkable work which has been done in this field by organizations representing the fire underwriters. Valuable work has also been done in this connection by the United States Bureau of Standards and the American Society for Testing Materials. The Underwriters' Laboratories, however, naturally limit their work to appliances and materials which have to do with the safety of buildings, especially as that safety is menaced by the fire risk. The American Society for Testing Materials deals with materials only, and not with appliances.

The engineer responsible for the construction of a building, however, has the task of selecting from a great variety of appliances for heating, lighting, ventilating, cleaning, finishing, etc. Competing manufacturers urge upon his attention appliances which may appear to have great merit, if one could believe the salesmen's stories, and yet when actually installed may prove to be seriously defective. The purpose of the Building Data League is to provide, through the coöperative action of the engineers and architects associated in the league, for systematic testing and rating of appliances, etc., which are on the market for use in building construction.

Among the incorporators of the league are such well-known engineers as Gustav Lindenthal, Henry C. Meyer, Jr., Prof. James F. Kemp, of Columbia University, and Prof. Arthur H. Blanchard. Among the prominent architects who have joined the organization are Guy Lowell, architect of the New York County Court House, Walter Smedley, R. Clipston Sturgis, Walter F. Ballinger, and Albert Kahn.

Associated with the league is the Building Data Co., a corporation which under the direction and authority of the league is to establish a bureau for the purpose of making tests, standardization, etc., apparently planned along lines similar to that of the Underwriters' Laboratories. The directors of the company are William A. Aiken, Louis K. Comstock and Bevan Jones. The offices of the two organizations are at 105 W. 40th St., New York City.

News of the Engineering World

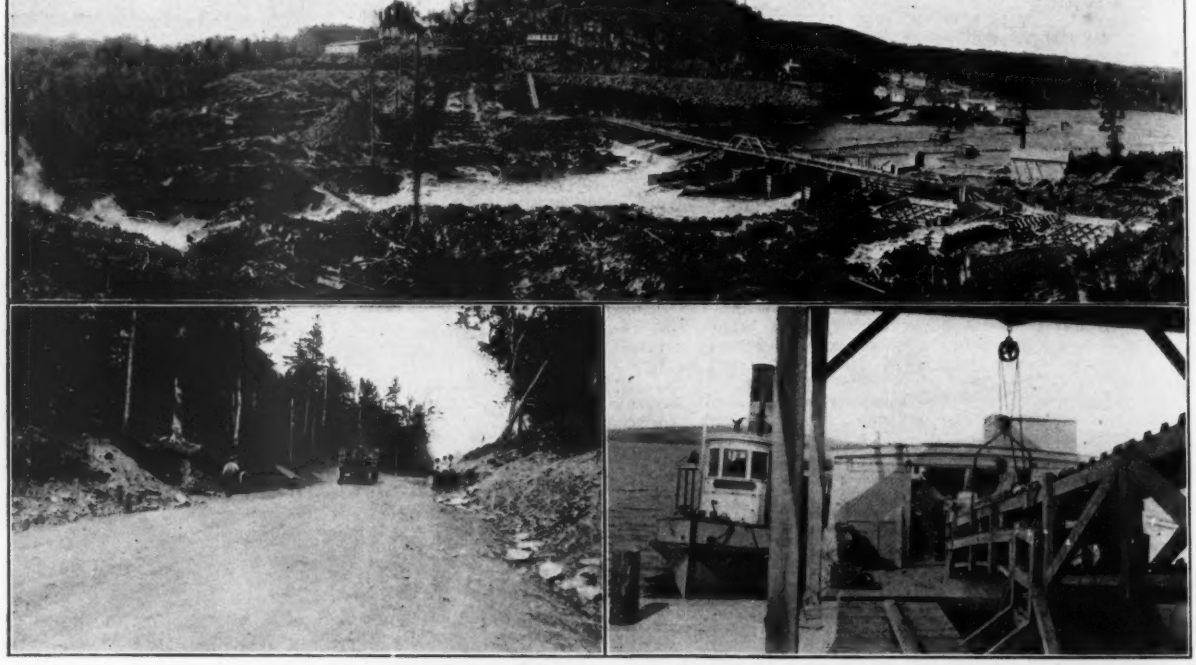
Ripogenus Dam on the Upper Penobscot in Maine

There is being constructed at the head of the well-known Ripogenus Gorge on the Upper Penobscot in Maine a large masonry dam at a site 50 miles from the nearest railroad and 30 miles across the famous Maine woods, to a point on Moosehead Lake, the nearest terminus of steamboat or rail transportation. The dam is being erected for the Great Northern Paper Co. to create a storage reservoir for the mills of that company farther down the Penobscot. While the possibility of future hydro-electric power is considered in the design, no provisions are to be made at present to care for such power development.

The accompanying views show the work in recent stages. The site was entered in March of this year, but from that time up till about the 1st of July, work was only preliminary to the actual placing of the concrete, which started early in July. It is hoped to complete the work in about one year's time. The dam will be about 1000 ft. long and will have a maximum height of 80 ft. It is of gravity section of mass concrete and will carry a bridge across its crest. The storage basin formed will be about 25 miles long, with a capacity of about 21,000,000,000 cu.ft. of water.

Because of the remoteness of the region, the problem of transportation of materials and supplies was most difficult and was solved only by the building, for 30 miles through the forest, of a wide highway, a view of which is shown at the lower left of the three views, from a point on Moosehead Lake, where the cement and supplies are delivered on a specially constructed scow shown in the lower right-hand view, by means of a belt conveyor, to motor trucks which transport the material over the road to the dam site. Nine 5-ton motor trucks, as well as a number of tote teams, are constantly traveling over the road, which is maintained by a regular section gang.

The stone for the concrete is obtained from a quarry just back of the rim of the gorge. The rock taken from this quarry is dumped into a crusher plant located practically in line with the dam and shown in the background in the view. The mixing plant is below the crushing plant, and the concrete is to be laid across the dam by chutes. Sand is obtained in a near-by bank and washed by a brook that is diverted from its natural bed to the top of the sandbank and banked up by a series of baffle dams so as to form settling basins.



BUILDING A CONCRETE DAM IN THE MAINE WOODS 50 MILES FROM A RAILWAY

Upper view—Looking across the river to the crushing and mixing plant. Temporary bridge at right and dam excavation in middle background. Lower left view—The motor highway for transporting material. Lower right view—Loading cement from point on Moosehead Lake

The construction is being carried on by a force living at the dam site. A village of about 500 people has sprung up, complete, with its stores, stables, dining camps, offices and cottages. Thorough sanitary precautions have been taken, and electric lighting is furnished.

The dam was designed by Hardy S. Ferguson, 200 Fifth Ave., New York City, and is being built by the Aberthaw Construction Co., of Boston, with E. W. Prouty as Resident Engineer and W. D. Maxson as Superintendent of Construction.

Erection of 591-Ft. Steel Arch Begun at Cleveland

On Thursday, July 29, the first permanent steel for the 591-ft. main arch of the Detroit-Superior viaduct in Cleveland was set. The view herewith shows the end lower-chord section of the south arch set in place at the east river pier. The work on the west bank is about two weeks behind this stage.

The end-chord section is the heaviest erection piece, weighing about 30 tons. It connects to the cast shoe by a 16-in. pin and carries an end-post 90 ft. long. The backstay will be attached to the top of this post, but the attachment can be made only after erecting the first panel on falsework. The adjusting toggle in the backstay is only half erected at present; the remaining bars and the upper backstay eyebars will be set as the erection of the first panel proceeds.

The Detroit-Superior bridge design was described in *Engineering News*, June 18, 1914, p. 1348. The King Bridge Co., Cleveland, has the contract for the steel arch. F. F. Buck is in charge for the Ferro Construction Co., Chicago, erection subcontractors.

ERECTING THE END-CHORD OF THE DETROIT-SUPERIOR BRIDGE ACROSS THE CUYAHOGA RIVER, CLEVELAND

New York Utility Commissions' Power Limited

The recent decision of the New York Public Service Commission for the First District in the rate case of the Ulster & Delaware R.R. has raised questions in the minds of the commissioners and the railway men of the state as to the extent of the control over rates vested in the commission—at least so far as railways are concerned. The commission, by a vote of three to two, decided that it could not raise passenger rates above 2c. per mi. for mileage books and 3c. for tickets, on account of statutes fixing such limits. The dissenters hold that the legislature intended to delegate its entire control to the commissions—not merely its power to reduce rates; and that the old mileage-book law was allowed to remain on the statute books to serve as a general guide in making new passenger rates pending any ruling of the commission that should change them. The case will probably come before the highest state court.

A Court Receiver for the City of Nashville, Tenn.

The commission form of government was adopted for Nashville by an act of the legislature of Tennessee, Feb. 19, 1913. The city had previously been governed by a mayor and Board of Councilmen. The mayor who was elected under the old form of government in October, 1909, became the mayor and chairman of the new Board of Commissioners. There were four other commissioners. The city owns its water-works and the electric plant for street lighting, besides certain parks.

About the first of this year it became known that the finances of the city were getting in bad shape and that there was a growing deficit, said to amount to about $900,000. The annual expenditures of the city are about $2,000,000. An audit of the city's books was asked for and at first was refused by the commissioners; but later, after some negotiations, it was agreed to, with an "efficiency survey" also to be included with the audit. Bids were taken and the contract for the audit was awarded to James Cameron & Staff of New York, the audit to begin June 14.

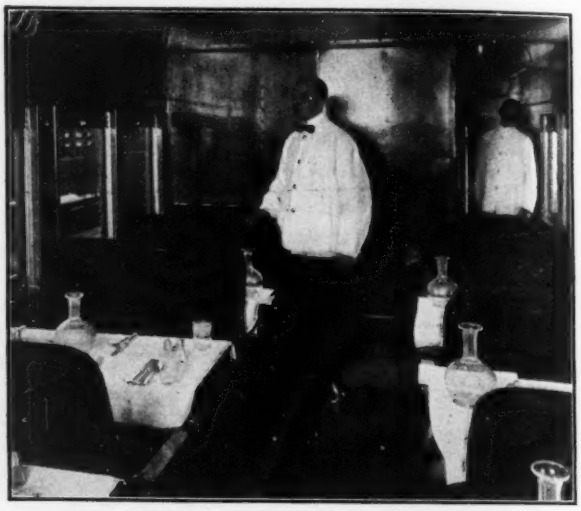
On June 12 it transpired that some of the account books were missing from the City Hall, and the mayor tried to suspend the city controller. Litigation followed, various officials were arrested and one fled. On June 25 application was made to the courts for a receiver for the city, and this was granted July 27. In the meantime one of the commissioners was suspended, another resigned and successors were appointed. This left three of the old commissioners in office with two new ones. On July 27, two of the old commissioners were removed from office by the court and a receiver was appointed and given full power to take complete charge of the city and its affairs. Later, however, the Court of Civil Appeals annulled the order of the lower court appointing the receiver. This leaves the government of the city in the hands of three commissioners, who have the power to elect other members and complete the board. The city is therefore not in the hands of a receiver at present.

In the proceedings incident to the receivership it has been brought out by the evidence that there has been in recent years extravagance and more or less petty graft; also it is known that there has been defalcation, the exact amount of which is not revealed.

The city is not bankrupt, however, nor is it insolvent. There is assessable property of $80,000,000 value, subject to taxation, and the city has a bonded debt of $8,000,000. Default has not been made on this in principal or interest. There will have to be retrenchment, and the official audit is proceeding to determine just what is the city's financial condition.—John Wilkes, Nashville, Tenn.

Cafe Service in a Day Coach

A coach café is the latest addition to the rolling equipment of the Pennsylvania R.R. The new car is an all-steel coach with a broiler buffet from which meals will be served. It will be tried out as an experiment, and if it is found to meet a sufficient demand on the part of the traveling public, other cars of like character may be placed in operation. It will not be used, however, to supplant dining cars.



DAY COACH PROVIDED WITH DINING TABLES

The new car is intended for use on trains where a dining car is not warranted by the travel. The buffet occupies about 8 ft. of space at one end of the car and is similar to those installed in broiler-buffet Pullman cars, but is of an improved type, alcohol broilers being used instead of coal fires. Meals will be served on tables placed between the seats, with the outer ends resting on the arms. Both single and double tables are provided, the latter being used where two seats are turned to face each other. At a double table a party of four can eat together. No extra fare will be charged for riding in the coach café car. It will be in the regular service as an ordinary day coach.

The car has a seating capacity of 70, and except for the buffet it is exactly like the heavy modern steel day coaches used by the Pennsylvania R.R. It was built at the company's shops at Altoona, Penn. A supplementary use for the coach café car will be to serve breakfasts in sleeping cars on the same train, where no buffets or dining cars are provided. It will be remembered that some years ago this railroad inaugurated a quick-service lunch-room car on its Washington-New York line.

Hydro-Electric Plans Grow

At a banquet held in London, Ont., on July 22, to celebrate the formal opening of the London & Port Stanley Ry. (the first line in the province operated with power from the Hydro-Electric Commission), Sir Adam Beck, chairman of the commission, stated that shortly plans would be submitted to the Ontario government for the extension of the system. It was proposed to provide for the development of 100,000 hp. at Niagara Falls and at the spillways of the Welland Canal. The work would entail a capital expenditure of approximately $10,000,000, and would require three years for its completion. It was explained that of the water available on the Canadian side of the Falls only 6600 sec.-ft. was left, and that the engineering plans had been drawn to utilize this at maximum head. The plans would be capable of extension to develop finally 600,000 hp., including the output of a development at Chippewa Creek. Sir Adam predicted a sweeping cut in power prices when the new development had passed its initial stage.

Earth Slip Wrecks Cement Plant at Hudson, N. Y.

Early in the morning of Aug. 2 an earth slip on the site of the Knickerbocker Portland Cement Co.'s Greenport plant near Hudson, N. Y., caused the subsidence of nearly 15 acres of ground carrying down to practical destruction the power house, coal trestle, machine shop and several smaller buildings. A number of workmen were caught in the power house and were burned by the escaping steam, five so severely that they afterward died.

The plant was located alongside a small creek on a bed of blue clay through which no borings appear to have been recorded, but which was of such stability as to warrant the erection of the building footings without the interposition of piles. The group of buildings affected comprised the steel and brick power house, 77x85 ft. in plan, a concrete chimney about 175 ft. high, a concrete storage tower 10x10 ft. in plan and 60 ft. high, a concrete conveyor shed, and a frame barn. Alongside of the power house was a coal trestle and somewhat farther away a storage pile of broken trap rock, piled in conical shape about 160 ft. in diameter and 45 ft. high. It was estimated to contain about 30,000 tons of stone.

The first indication of the slip was an upheaval of ground about 50 ft. in length alongside of the creek; this was followed by the subsidence of the stone pile which dropped vertically about 25 ft. and caused the heaving of the ground around the buildings and their ultimate collapse. The power house collapsed and the barn was moved bodily over toward the creek, which in turn was so filled by earth as to divert it from its course. The concrete structures, while disturbed and shifted from their foundations, appear to have suffered little structural damage.

There are local stories of a similar slip on this same site many years ago, but these rumors seem not to have been of sufficient importance to warrant consideration when the plant was constructed. A small slide occurred between the power house and the creek behind it in the fall of 1914. This area, mostly cinder fill, was then protected by three rows of piles to a penetration of 40 ft. No further movement was noted, until this week.

The Maintenance of Water Meters cost $3.57 per meter in Chicago, Ill., in 1914. During the year an experiment was made by using a small motor truck for the work of the meter division in place of a horse and wagon. The operating expenses and fixed charges of this car, including interest and depreciation, were lower than the cost of operating the wagon, and a great deal more work was done by using the motor car. The cost of maintaining water meters in 1913 was $3.97 per meter.

Patrol of Transatlantic Steamship Lanes—A patrol of the Grand Banks in the vicinity of the transatlantic steamship lanes, for the detection of icebergs and ice floes and for warning vessels of these dangers, is being maintained in accordance with an international agreement entered into by the maritime nations of the world at the London Convention, held early in 1914. For the United States the Coast Guard cutters "Seneca" and "Miami" are assigned to this work. The "Seneca" carries a detail of four scientific men.

Progress in Toronto Harbor Improvements—In this, the second year of the Toronto harbor development, $2,000,000 is being spent on the city's water front between the Don and the Humber Rivers. Last year $1,400,000 was spent, of which $1,100,000 was expended in piles, cribs, dredging, and filling. The cost is about equally divided between the Harbor Commission and the Dominion Government. In spite of the war conditions prevailing, it is stated that the harbor-improvement work will continue without interruption. Of the total estimated cost of the improvements ($24,000,000,), contracts for nearly $11,000,000 have been let.

Chilean Railway Shops—As early as February, 1914, there was advertised an international competition for the plans and specifications of a central model workshop and four repair shops for the state railways of Chile. Full details of this competition were published in "Engineering News," of Mar. 5, 1914. The winner of the first prize of $20,000 was announced on May 1, 1914, by the Chilean Government to be the Niles-Bement-Pond Co., of New York City. A second prize of $10,000 was awarded to a Chilean firm. An article in the June 14 issue of the "Ultimas Noticias" of Santiago, Chile, indicates that construction work on these shops has not yet begun, although the land has been purchased in the town of San Bernardo, near Santiago. The shops were estimated to cost about $3,650,000.

Road Mirrors at Street Intersections—In a number of English towns and cities large mirrors have been erected at important road intersections to enable drivers of motor cars approaching the junction to see whether a car is approaching the corner on the other road. A recent United States Consular report quotes the "Times of India" as stating that the municipality of Bombay will erect a mirror 10 ft. long and 3 ft. high, at a dangerous street intersection in Bombay. The use of mirrors for the same purpose is also reported at Glencoe, Ill., where a mirror 8 ft. long and 6 ft. high has been placed at the intersection of two much-used streets. The idea is a simple one and may be worth extensive adoption. Probably it would be necessary to provide for the systematic cleaning of such mirrors if erected, however. One at a much-used road intersection, exposed to the dust and weather, might soon become so obscured as to give no clear indication, in which event it might be a source of danger rather than of safety.

A Flush Tank System in which the sewage itself is used for flushing was described by Isaac Shone, the inventor of the Shone compressed-air ejector for handling sewage, at the annual meeting of the Institution of Municipal and County Engineers of Great Britain. Mr. Shone, who is nearly 80 years of age, has developed this flush tank system to eliminate the disconnecting trap commonly required in British plumbing practice between the soil pipe system and the public sewer. The flush tank is a closed cast-iron chamber having a capacity of a dozen to twenty gallons. The sewage discharges into it until it is full, when it automatically empties itself by siphon action. Mr. Shone intends this apparatus, according to the description in his paper, for use on combined sewer systems where the rain water from the roofs as well as the house sewage is dischargd into the sewer. With the frequent rainfall in the humid climate of England, frequent discharge and consequent flushing of the lateral sewer would be much more effectively secured than would be possible where the separate system of sewage was in use or in a climate where long periods of drought occur.

A Remarkable Growth in Population is shown by the village of Hamtramck, Mich., a northeastern suburb of Detroit. The United States Census Bureau has just taken a special census of this village, which had a population of 3559 in 1910, and its present population is 21,520, an increase of 504% in five years.

A Hotel Dining-Room Floor Collapsed at Holland Station, Rockaway Beach, on the afternoon of Aug. 1, burying about 30 persons in the wreckage, nine of whom were injured. The outdoor dining-room of the hotel is built on a level with the boardwalk and extends out over the beach. Examination following the collapse showed that the floor-beams were badly decayed.

New York Subway Contracts aggregating $7,022,000 were awarded by the New York Public Service Commission last week, and it is expected that another contract amounting to nearly $1,700,000 will be awarded this week. The largest contract was for the Broadway subway extending from 38th St. to 51st St., which went to the Holbrook, Cabot & Rollins Co., at $3,740,000.

A Schedule of Rates for Engineering Work was adopted in 1912 by the Washington Association of Engineers, Seattle division. The charges are classified under three schedules: (a) Surveying, (b) structural engineering, (c) civil engineering. Provision is made for charges both on the basis of percentage and on per diem rates for a variety of classes of work, including court testimony.

A Record July Rainfall is indicated by the charts from the rain-gage at Chestnut Hill reservoir, Boston, Mass. For the month of July a total rainfall of 10.68 in. was recorded, which is the heaviest precipitation for that month in Boston, Mass., since 1863, and with the exception of 1835 and 1862, the heaviest since 1817. The record of the United States Weather Bureau at Boston was 8.85 in.

A Tunnel Under the East River from 60th St., Borough of Manhattan, to the Queensboro Bridge Plaza, Borough of Queens, favorable action on which was taken recently by the Board of Estimate of New York City, as reported in last week's issue, has now been formally approved by the Public Service Commission. At its eastern end the tunnel will connect with the lines of the rapid transit system running to Astoria to the north and Corona to the northeast.

A Railway-Terminal Plan proposed for London, England, provides for a ring of nine outlying main-line terminal stations connected by an electrically operated belt line. No trains, either main-line or suburban, would enter the inclosed area, but all passengers would have to change cars. The interior or local traffic would be handled by the present underground lines (high and low level) and the lines abandoned for main-line service, with suitable extensions and connections. This plan has been suggested by H. J. Leaning and is described in "The Engineer," of London, June 25. Unfortunately these various lines, built and operated by different companies at different times, form a very unsystematic "system" for the purpose proposed. The question as to whether main-line passenger terminals should be within or outside of the business district of a city has been discussed many times, but the almost universal tendency is to bring them as far as possible into that district. The plan proposed for London goes to the extreme of putting the stations far out in the suburbs.

PERSONALS

Mr. J. T. Breckon, Water-works Engineer of Vancouver, B. C., resigned from that position on July 31. He will resume private practice as consulting and construction engineer, with offices in Vancouver.

Mr. W. R. Cahill, formerly Superintendent of the Union Pacific R.R. at Omaha, Neb., has been made Superintendent of the Texas division of the Missouri, Kansas & Texas Ry. at Wichita Falls, Tex.

Mr. J. H. Elliott, Superintendent of the New Orleans division of the Texas & Pacific Ry., has been appointed General Superintendent, with headquarters at Dallas, succeeding Mr. J. E. Paussit, resigned.

Mr. D. C. Miller, for the past year Assistant Professor of the Department of Civil Engineering, Agricultural and Mechanical College of Texas, has been promoted to Associate Professor of Civil Engineering.

John Sweeney, formerly District Engineer for the Canadian Department of Public Works at Winnipeg, succeeds Mr. C. H. Mathewson as resident engineer for the Department on the Toronto Harbor Improvement Board.

Mr. O. E. Hunt, recently Assistant Chief Engineer of the Packard Motor Car Co., has been made Chief Engineer of the company under Mr. J. G. Vincent, M. Am. Soc. M. E., Vice-President in charge of Engineering.

Mr. C. H. Mathewson, Resident Engineer on the Toronto Harbor improvement project for the Canadian Government, has been appointed District Engineer for the Department of Public Works of the Dominion at Winnipeg, Man.

Mr. Kenneth C. Grant, M. Am. Soc. C. E., for the past two years with the Morgan Engineering Co., Dayton, Ohio, has been appointed by Governor Willis of Ohio to represent the state at the Fifth National Drainage Congress to be held in San Francisco, Sept. 17 to 21, 1915.

Mr. Philip P. Farley, M. Am. Soc. C. E., formerly President of the Jamaica Bay Improvement Commission and recently Consulting Engineer to the New York State Highway Department, announces the opening of an office at 103 Park Ave., New York City, for private practice.

Mr. S. T. Cantrell, former Assistant Superintendent at Cumberland, Md., of the Baltimore & Ohio R.R., has been promoted to the office of acting superintendent of the Cumberland division of that railroad. Mr. Cantrell was formerly Superintendent of the St. Louis & San Francisco R.R.

Mr. Ray Palmer, for the past three years Commissioner of Gas and Electricity of the City of Chicago, has resigned. During his term of office about $4,000,000 has been spent in rehabilitating the city lighting system and replacing old-style arc lamps with modern tungsten filament units.

Dr. A. S. McAllister, F. Am. Inst. E. E., has resigned as Editor of the "Electrical World" and has also severed his connection with the McGraw Publishing Co. Dr. McAllister is President of the Illuminating Engineering Society and a member of the American Society of Mechanical Engineers.

Mr. Theodore T. Seelye, recently Division Engineer of the Water Supply Commission of Pennsylvania, in charge of the examination of dams, has entered partnership with Mr. Farley Gannett, Assoc. M. Am. Soc. C. E., former Chief Engineer of the Water Supply Commission, with offices in the Telegraph Building, Harrisburg, Penn.

Mr. William A. Del Mar, M. Am. Inst. E. E., has resigned from the engineering staff of the New York Central & Hudson River R.R. to accept a position with the Interborough Rapid Transit Co., of New York City. Mr. Del Mar's time will be largely given to working out the problems of the operation of the new subways now nearing completion in New York City, which are to be operated by the Interborough Rapid Transit Co.

Mr. A. C. Love, for the past two years Associate Professor of Civil Engineering of the Agricultural and Mechanical College of Texas, has been appointed Professor of Railway Engineering and head of the newly created division of railway engineering in the civil engineering department of the college. Professor Love has had a number of years' experience in railway engineering work with the Atchison, Topeka & Santa Fé and Southern Pacific railways.

Mr. W. B. Poland, M. Am. Soc. C. E., former Vice-President and Chief Engineer of the Philippine Ry., has returned to this country after a several months' trip through Australia, Japan, New Zealand and South America. He has entered the service of the American Commission for Relief in Belgium, and will leave New York City for that country on Aug. 16 for a six months' absence. Mail should be addressed to the Commission for Relief in Belgium, 71 Broadway, New York City.

Lieut. Col. Thomas A. Flagler, Corps of Engineers, U. S. A., has been ordered to Washington, D. C., for duty in charge of the District of Columbia water-supply system and all rivers, harbors and fortification work in that vicinity, relieving Col. Henry C. Newcomer, Corps of Engineers, U. S. A., who will, however, remain in Washington as a member of the Board of Engineers on Rivers and Harbors and of the National Land Defence Board. In the summer of 1914, Lieut. Col. Flagler was in Vera Cruz, Mex., as Chief Engineer of the expeditionary force commanded by General Funston. Since last fall he has been on duty at the Army War College.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Aug. 16-18 and 25-28. Annual meeting in Los Angeles, Calif., Aug. 16-18; in San Francisco, Aug. 25-28. Secy., J. C. Olsen, Cooper Union, New York City.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 24-27. Annual convention in Cincinnati. Secy., Clarence R. George, Houston, Tex.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 7-9. Convention in New York City. Secy., Willard Kent, Narragansett Pier, R. I.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual meeting in Chicago. Secy., W. O. Thompson, N. Y. C. R.R., East Buffalo, N. Y.

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

San Francisco Meetings

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 19-21. Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo.

INSTITUTE OF RADIO ENGINEERS.
Sept. 13-18. Secy., David Sarnoff, 71 Broadway, New York.

PAN-AMERICAN ROAD CONGRESS.
Sept. 13-18. Secy., E. L. Powers, Road Builders Association, 150 Nassau St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Secy., Bradley Stoughton, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Secy., J. J. Blackmore, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Sept. 17-21,

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.; until Aug. 1, New Stockton, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

Connecticut Society of Civil Engineers—The summer meeting will be held on Wednesday, Aug. 11, and will consist of an inspection of the plant of the New Haven Trap Rock Co. at North Branford, Conn., and an old-fashioned Connecticut clam bake at 1 p.m., the latter prepared under the direction of Capt. Tom Scott, who is alleged to "know how." The trip will be made in two street cars, which will leave Railroad Station, New Haven, at 9:45 a.m. The trap rock at North Branford is 150 ft. or more in depth, and the company owns about 600 acres. The president of the society is Charles C. Elwell; the secretary is J. Frederick Jackson, New Haven.

Engineers' Society of Western Pennsylvania—About 150 members of the society inspected the Magnolia Cutoff on the Cumberland division of the Baltimore & Ohio R.R. on July 17 as guests of the railroad. The start was made from Pittsburgh at 9 a.m., arriving home at 10 p.m.

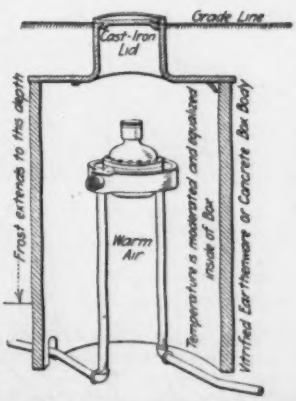
American Society of Civil Engineers—The 47th annual convention of the American Society of Civil Engineers opens in San Francisco, Calif., at 10 a.m. on Thursday, Sept. 16, with welcoming addresses and the annual address of the president, Charles D. Marx. The business meeting will be held immediately afterward. The afternoon will be devoted to visiting the Panama-Pacific International Exposition. The informal reception, dinner and dance will be held at Old Faithful Inn, Exposition Grounds, at 6:30 p.m. Very little business is scheduled for Sept. 17. In the afternoon there will be an excursion to Del Monte, where on Sept. 18 will be held a golf tournament, with dancing in the evening. Early on Sept. 19 the party will leave for Santa Cruz, thence to Big Tree Basin, going to San Jose for dinner and returning to San Francisco late the same evening. A general invitation is extended to all members of other societies and to other members of the International Engineering Congress to participate in the various features of the civil engineers' program.

International Engineering Congress—All meetings of the congress will be held at the Civic Centre Auditorium in San Francisco. The opening session will be at 10 a.m. on Monday, Sept. 20, at which there will be general addresses of welcome, with responses, and an address by Gen. George W. Goethals, honorary president of the congress, after which the John Fritz medal will be presented to Dr. James Douglas. A general session in the afternoon will be devoted to the Panama Canal. During the remainder of the week sectional meetings will be held morning and afternoon, ending with a brief closing meeting on Saturday, at 11:30 a.m. No meetings of the congress will be held in the evenings; but on the evening of the opening day there will be a general reception and ball and on the evening of Sept. 24 a subscription dinner will be given.

Appliances and Materials

Water-Meter Coupling Yoke

A yoke for the convenient setting of water meters has been devised by the H. W. Clark Co., of Mattoon, Ill., and is shown in the accompanying sketch. A cast-iron ring is fitted with brass water connections and a screw clamp for the meter. To install the yoke it is necessary to cut the service pipe only once. The cut ends are bent apart and threaded, and elbows and risers are screwed on. The ring section is screwed on to one riser and the brass-slide section to the other. No unions or right-and-left fittings are required. For basements the yoke is furnished with one piece tapped on top for the house pipe.


Grade Line
Cast-Iron Lid
Frost extends to this depth
Warm Air
Temperature is moderated and equalized inside of Box
Vitrified Earthenware or Concrete Box Body

CLARK METER YOKE

* * *

Bottom-Dump Motor Truck

A unique bottom-dump motor truck particularly designed for contractors has been developed by the Watson Wagon Co., of Canastota, N. Y. One of these trucks is shown in the accompanying illustration. The bottom-dump feature is made possible by the use of a front drive. This also permits the use of steel tires on the rear wheels and the distribution of load equally between front and rear—features which are reported to appeal to contractors from their experience with damp wagons. The body (5 tons or 100 cu.ft. capacity) is made of birch plank reinforced with 3½x7-in. steel angles and is lined with steel plates (steel and asbestos for asphalt carriers). The rear wheels are set back of the body and have 5-in. steel tires and roller bearings. A

service brake acts on all four wheels and an emergency brake on the rear ones. The winding of the dumping bottom is the same as in all Watson wagons.

The drive is of the Latil (French) type developed in America by the Walter Motor Truck Co., of New York City. The engine and transmission form a single group mounted on a three-point suspension over the front axle. The speed-change and differential gears are in a casing bolted to the rear of the crank case. Above and parallel with the main shaft is a secondary shaft driving the differential gear. Four forward speeds and a reverse are possible. Gear-shifting levers are on top of the transmission case in the center of

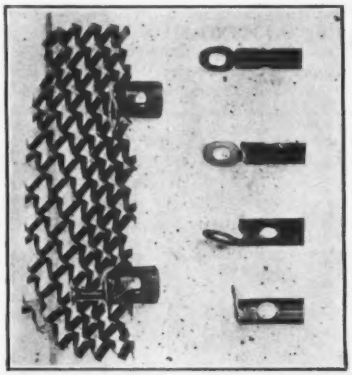
BOTTOM DUMP CAR

the cab. The drive from the differential to the front wheels is through two inclosed cardan shafts with universal joints. The gears and pinions driving the wheels are inclosed in a housing, which carries a stub axle and arm for the steering rod. The truck sells for $4000.

* * *

Post Support for Metal Lath

A new support for metal lath, designed to eliminate the troubles encountered with wood furring strips, and having depressions in the lath sheet to accomplish the same purpose, has been devised by the Wagner-Behm Co., 20 East Jackson Boulevard, Chicago. This device, called the "Furr-Easy Post," is shown in the accompanying views. It consists of steel tubes, of various lengths, left open on their sides and back



POST SUPPORT FOR METAL LATH

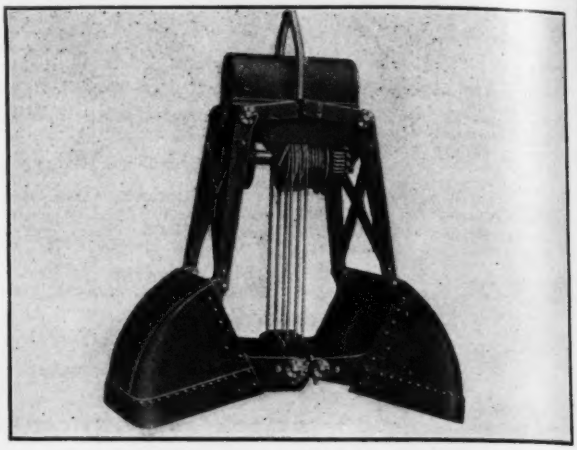
for the entrance of protecting plaster, and provided with a clinching lip. In use, a post is slipped through the lathing, the lip is turned down over one strand and a nail of any desired length is driven through lip and tube. A 26-gage lath sheet can be made stiff and rigid with 12 posts per square yard.

This fastening is also intended for use in spacing mesh reinforcement and light rods in concrete floor-slabs, in fastening wire screens and guards, etc.

* * *

Grab Bucket with an Electric Motor

A grab bucket operated by an electric motor mounted on the top head is now being made by the Mead-Morrison Manufacturing Co., of East Boston, Mass. It is intended particularly for use with electric traveling cranes. The closing purchase is secured by sheaves on the top and bottom heads and a six-part line going to a drum which is driven by the motor through a silent chain, reduction gear and slip clutch. The clutch is provided to operate in case the operator fails to shut off current as soon as the bucket has closed. The



MOTOR-OPERATED GRAB BUCKET

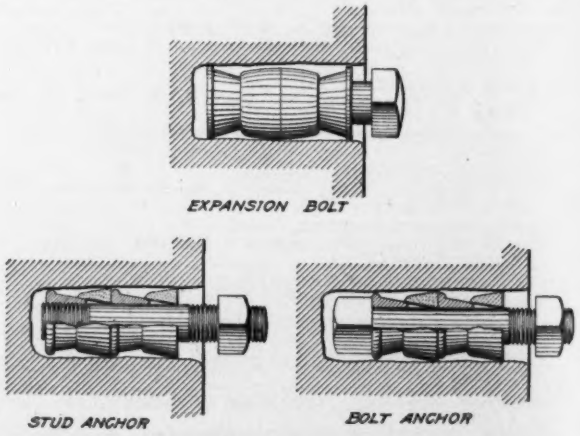
motor has a removable top cover. Power is furnished through a flexible cable running to a controller in the crane cab; a simple plug connection is used at the bucket. Ordinarily, no provision for reeling in the slack of the cable is needed, but that can be provided where desired. These buckets are made regularly in 1½- and 3-yd. sizes, weighing 4500 and 8900 lb. respectively.

* * *

Expansion Anchor Bolts

A system of bolt and stud anchorage, to be designated as the "Cinch" type, has been developed by the National Lead Co., of New York City. The expansion unit consists of a malleable-iron conical male wedge and a lead-composition female ring. The latter is expanded by driving it over the former until it engages the sides of the wall hole, as seen from the accompanying sketches. Three kinds of anchors are now made up—(1) expansion bolts, (2) bolt anchors and (3) stud anchors. The first consists of two or more expansion units, the leading one being threaded and every pair reversed so that the soft leads come together. The bolt anchor consists of plain units slipped on a machine bolt in regular order (alternate irons and leads). The stud anchor is like the bolt anchor, except that the first iron is threaded.

The expansion bolt is fastened in place the same as any other design—by turning the bolt head. The other anchors



IRON-LEAD ANCHORS

are fastened in place by hammer and tube. The expansion bolts and plain anchors are furnished in all commercial sizes and lengths from ⅜x¾ in. ($8.70 per hundred) to 1½x20 in. ($285 per hundred). The stud anchors are sold in sizes from ⅜x1 in. ($11 per hundred) to 1½x10 in. ($260 per hundred).